POWER

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Stringency

THERE was one of those towns that travelers remarked upon as they passed through and the citizens of which regarded with a fond consciousness of its superiority.

The houses and gardens were clean and well kept, the lawns and shrubbery trimmed and cared for. The common with its big elms, white fences, bandstand and benches, the business center with its attractive store fronts and well-swept street and sidewalks conveyed by their order and cleanliness a pleasing sense of interested upkeep and prosperity.

But there came over the town a sense of impending stringency and penuriousness. The local financial solon had said that there were clouds in the offing and it behooved one to sit tight.

People did not do the usual spring refurbishing and the carpenter and painter had to let men go. Cars and implements, clothes and furnishings would go for a time longer. The number of jobless increased. The business of the local merchants and tradesmen fell off. To Let signs appeared upon a number of the erstwhile busy stores.

Even the Town had to retrench on fixing-up expenses to take care of its dependents, and every dollar that it did not spend for maintaining its high grade of municipal housekeeping was likely to have to be spent to feed somebody who might otherwise have earned it.

The aspect of the Town became slack and slovenly, down at the heel. Property deteriorated, values decreased and a pall of gloom and discouragement hung over it all.

But sometime there will come a realization that this is the same old Town of which they were once so proud, in the same picturesque setting, cheered by the same bright sun, with the same resources, associations and possibilities. And there will come resignation to losses sustained, confidence in the future honest effort to pay up, pride in obligations met, ambition to restore the old prosperity and proud appearance, relaxation of the purse strings and a gradual restoration of the old order.

EDITORIALS

Defending Engineering

IN A recent news release the Engineering Foundation rises in defense of engineering. It appears that, after all, engineering is a good thing, and that we are better off with machinery than without it. In short, it is pleasanter to work for eight hours and enjoy good food, comfortable housing, entertainment and education than to sweat twelve hours daily over a hoe or axe for black bread and water.

For engineers this requires no argument. They feel sure that those who rant loudest against the machine age would be the first to call quits if suddenly reduced to the scale of living they could attain with spade, axe and spinning wheel.

However, nothing of the sort is likely to happen to test the soundness of these complaints. Lacking such a demonstration, it is perhaps well now and then to list for these critics the achievements of engineering in the service of human happiness. This the Engineering Foundation does at length. Fittingly, it mentions water supply, sanitary disposal of sewage and refuse, electric light and power. Improved communication facilities, the airplane, the camera and the press are likewise held up as tremendous contributions to the ease and joy of living.

Almost every bad feature of modern civilization is blamed by some on the machine, and yet for not one is the machine fundamentally to blame. The movies can furnish good pictures or poor. If patrons prefer the poor, it is not the fault of the moving-picture camera or of projector, but a defect in human taste. The printing press can produce good books and bad with equal facility. If the bad are preferred, the remedy is not to destroy the printing press, but to improve taste by education.

Many agree that most of the "crimes" of the machine are non-existent, but at the same time blame the machine for the great curse of unemployment.

In one sense machines do produce unemployment; that is, they reduce the number of man-hours required to produce the material needs of the world. They do not, however, reduce the quantity of food, clothing, etc., available to meet men's needs. If the business system shuts off some men from these goods, by refusing them employment, the fault is not with the machine, but, obviously, with the system.

Except as a temporary relief measure, it is childish to attempt to create employment by eliminating machines and engaging in the general promotion of inefficiency.

Oxidation of Lubricating Oil

A PRINCIPAL cause of oil deterioration is its oxidation and the consequent formation of weak acids and sludge. In turbine lubrication the sludge collects in the piping and coolers, preventing proper circulation and decreasing the value of the oil as a lubricant. In transformer service the sludge hinders circulation of the oil and causes hot spots by preventing effective cooling.

Electrical engineers have recognized the troubles caused by oxidation and have designed transformer oil circulation systems so that a minimum amount of oil comes in contact with the oxygen of the air. This has been accomplished by providing breather tanks. In some cases the vent to the tank is provided with equipment for removing the oxygen in the entering air, thus blanketing the oil with nitrogen and still further decreasing the opportunity for oxidation.

Such precautions are not apparent in turbine lubrication systems. Unsealed oil reservoirs in the turbine base and partly filled oil-return lines present every opportunity for oil and air to mix. As the oil is both agitated and hot, oxidation occurs, with the resultant formation of sludge, which if not removed, soon clogs up the lubricating system, impairs the lubricating qualities of the oil and eventually forces the unit to be shut down.

The troubles from oil oxidation have been largely overcome by filters and centrifugal separators, which remove not only the products of oxidation, but also water and other foreign material. Although turbine lubrication no longer presents such a serious problem, it may well be that additional service could be secured from a given lubricant if an effort were made to limit the opportunity for oxidation, since this would decrease, at is source, the cause of most lubricating troubles.

Know the Oil Engine Better

ONE of the speakers at the recent Oil and Gas Power meeting in Madison expressed the opinion that consulting engineers, in general, are not as well informed as they should be concerning diesel engines. Although possessing a general knowledge of this type of prime mover, they are less familiar with the designs, performance, installation, application and limitations of diesels than they are with steam equipment.

This may be due in part to having received their training and experience in steam plants, and in part to the opinion which prevailed until recently that the field of the diesel was very limited. Lack of constructive policy by the diesel manufacturers as a group may also have contributed.

The result has been that, with few exceptions, consulting engineers have not been in a position to prepare their own specifications for diesel installations without the assistance of the salesman, and this assistance is likely to incur limitations.

Statistical data as to performance are now available, and with developments in automatic control and waste-heat recovery new fields of application are opening.

The time has arrived for the consulting engineer to know the oil engine better.

Water-Power Statistics May Be Misleading

IN THE time-worn saying "familiarity breeds contempt" may be found the answer as to why statistics are sometimes compiled with apparently little thought of how they may be interpreted. A recent report on the world's water powers listed the resources of the various countries under the headings "Developed Horsepower" and "Potential Horsepower." The terms "developed" and "potential" are generally accepted as meaning "utilized" and "total available," respectively. Considering the report in this light, the impossible situation is found wherein some countries are making more water power than they have.

Available water power varies widely in different localities, and unless the basis on which it is estimated is given, the figures are likely to mislead. Rated on a minimum six months' flow the available horsepower will be about fifty per cent greater than when calculated on a minimum flow for ninety per cent of the time. It is therefore evident that if the term potential water power is used it should be qualified.

Using "developed horsepower" where "installed horsepower" of waterwheels is intended is another source of confusion in water-power statistics. The horsepower capacity installed, relative to available stream flow and head, will vary depending upon the river's characteristics, storage provided and load to be served. As a general proposition, the installed horsepower is about forty per cent greater than that available for a minimum six months' stream flow. On this basis, to develop all the water power in the United States would require installing about eighty million horsepower of waterwheels, or more than double the power available ninety per cent of the time.

This wide variation in stream-flow ratings and between installed capacity and available horsepower makes it necessary that care be taken in presenting their values. If statistics are to be of value they must be presented so that they can be used correctly. A little more care in compiling some of the water-power records would greatly increase their usefulness and prevent some wrong conclusions which have been drawn from them.

More Data Desired on Air Heater Performance

AS AIR PREHEATERS are comparatively recent additions to stationary power plant equipment, data covering their performance are not widely disseminated. Therefore a recent paper by W. H. Howden before the British Institution of Naval Architects on "Some Modern Examples of Air Heaters" is of more than passing interest. While the author's data refer specifically to marine practice, wherein the size of boilers and the rates of driving are below current practice on land, the results are instructive.

Mr. Howden reports on nine heaters, including some of the tubular, plate and regenerative types. He found that the rate of heat transmission per square foot per degree Fahrenheit temperature difference varied from one to two and one-half B.t.u. per hour. The percentage of the total heat in the fuel recovered varied from four to ten per cent, the higher values being obtained on modern high-pressure boilers where the flue gas temperatures were high. Another interesting result was the heat requirement of the fan expressed as per cent of the heat value of the fuel burned. This was about one-quarter of one per cent for the forced-draft fan.

It is hoped that others will follow Mr. Howden in presenting the results of tests on air preheaters so that there may be an abundance of performance data available for the guidance of designing and operating engineers.

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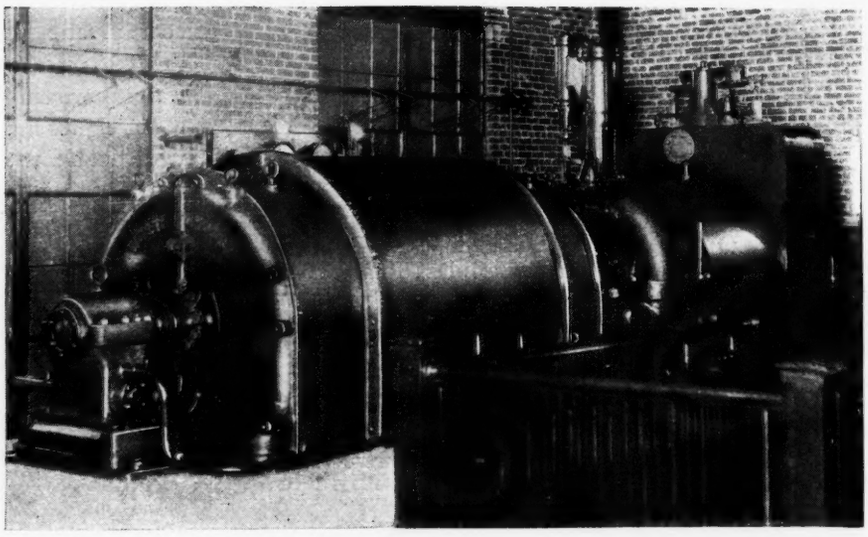
POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**



The turbine unit is of the bleeder, condensing type

SINGLE-UNIT PLANT SHOWS

THE Montana-Dakota Power Company operates a power property extending from Miles City, in the southeastern portion of Montana, to Mohall in the north central part of North Dakota. This property is served by a 33,000-volt main transmission line extending from Miles City to Kincaid, with branches extending both east and west. Power is supplied by four central stations, 75 to 100 miles apart, at Miles City, Glendive, Williston and Kincaid. Each station is equipped with one 2,000-kw., 2,300-volt turbine-generator. In the winter months the maximum peak on the system reaches approximately 6,500 kilowatts.

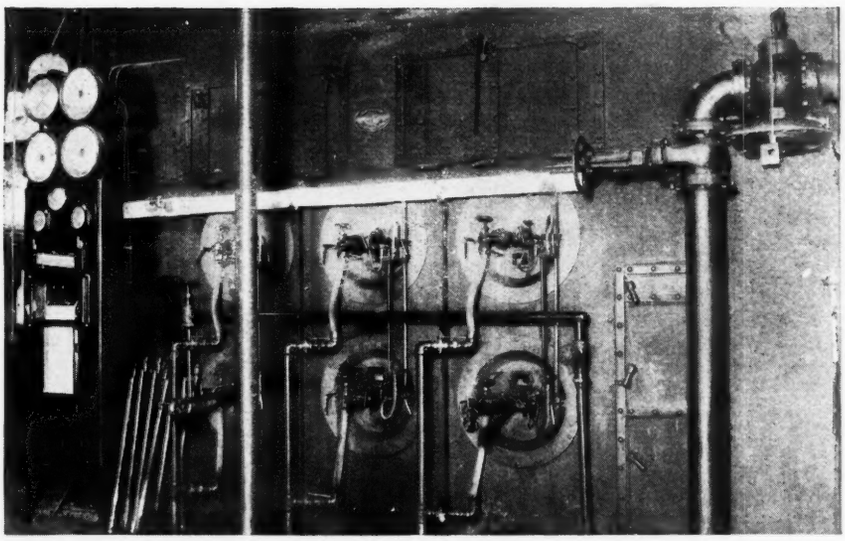
All four stations, which were designed by the writer, are similar in that they are equipped with but one main generating unit, with the exception of the plant at Glendive. When acquired by the company the latter property contained two 500-kw. condensing turbine units that received steam from three 2,500-sq.ft. Stirling-type boilers equipped with shaking grates for firing the North Dakota lignite. Later when natural gas was made available one 7,500-sq.ft. cross-drum boiler was added to burn this fuel and the older boilers were also equipped with gas burners. Prior to the installation of the new boiler, however, the present management had added a 2,000-kw. turbine-generator.

Emergency requirements are met through the proximity of the different stations and the total plant capacity of 8,000 kw. as compared with the winter peak of 6,500 kilowatts. For example, if the Miles City station is out of service power can be supplied from Glendive and the additional load thrown on to the Glendive plant can be shared by Williston and Kincaid, as all four stations are tied in on the main transmission line. The system is unique in that it covers a large sparsely settled territory in which the power demand is comparatively light. It has been built up within the last five years by the acquisition of a large number of small, inefficient plants, most of which have been discarded. The success of the undertaking is due largely to the energy and foresight of R. M. Heskett, vice-president and operating head of the property.

The Miles City station, the first completely new plant to be installed, has been in continuous operation since Feb. 1, 1928. The considerations underlying the design were as follows: Natural gas at 20c. per 1,000 cu.ft. was available for fuel from the gas transmission lines of the Montana-Dakota Power Company. The company had purchased the municipal plant at Miles City because it was desirable to use it for emergency until the transmission lines between Miles City and Glendive could be completed. Absence of a reliable stream for condensing made necessary either a cooling tower or a spray pond, and the dependence upon wells for the water supply. As the plant was a long way from the manufacturers of equipment, the fuel comparatively cheap and skilled help scarce, it was desirable that the layout be as simple as possible and as economical in the use of fuel as such a system would permit. Fortunately, this layout, from a dollar and cents standpoint, has worked out most economically. The plant was to handle the city peak of about 1,200 kw. with sufficient additional capacity to supply at least half the Glendive peak in the event of the shutdown of the turbine unit there. In addition the plant was required to supply a peak low-pressure steam demand for city heating of about 20,000 lb. of steam per hour under a pressure of 5 lb.

Equipment in the plant consists of one 2,000-kw. 3-phase, 60-cycle, 2,300-volt turbine-generator operat-

Simple one-boiler one-turbine 2,000-kw. plant burning natural gas shows efficiency of 81 per cent without economizer or air heater. Operation up to 250 per cent rating obtained with natural draft. These highly satisfactory results attributed to a furnace designed for large volume, long flame travel, preheat of combustion air in walls and floor, and use of high-pressure burners



Natural gas burners on the boiler front

HIGH EFFICIENCY

By C. M. GARLAND
Consulting Engineer
Chicago

ing under steam conditions of 250 lb. pressure and 125 deg. superheat. Steam is supplied from a 7,630-sq.ft. cross-drum boiler, designed to operate up to 250 deg. rating, which is provided with a hollow-wall setting through which the air for combustion is drawn. The air enters at the center of the rear wall, and passes in each direction through the side walls and underneath the floor of the furnace to a plenum chamber formed in the front end of the boiler setting. From there the burners take the air for combustion. Of the high-pressure type, they take gas at from 2 to 10 lb. pressure. Draft is produced by a reinforced concrete chimney 210 ft. high.

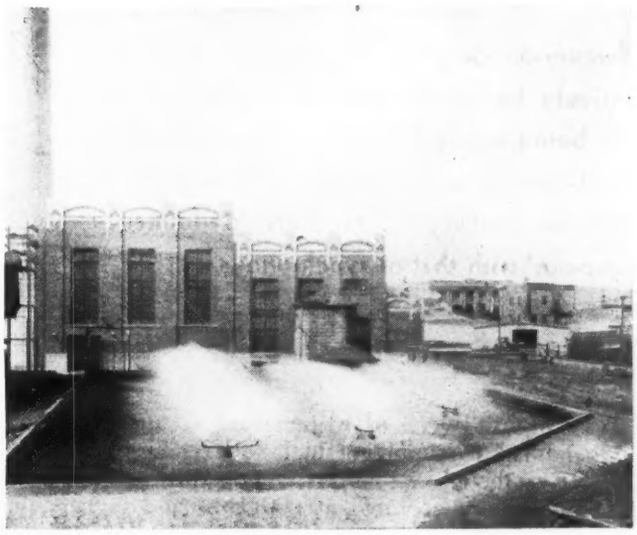
According to the records of the operators, in everyday performance this equipment shows a combined efficiency in the use of gas of 81 per cent without preheaters or economizers.

As applied to this boiler, the fuel-burning system was first worked out in the Glendive plant about four years ago. The installation is of interest because at the the time of the design it was probably one of the most efficient and most successful boiler installations of its type. Its success has been insured, first, through the long gas travel from the burners to the tubes, and, second, by the comparatively large furnace volume.

Within the past four years the writer has known of a number of failures in the use of natural gas under large boilers using the same equipment. An analysis in each case showed that the trouble was with the furnace and not in the burners, as the owners and the engineers who made the installation believed. In one instance the boiler installation, designed for operation at 300 per cent rating, would develop only one-half the anticipated capacity. During the short travel the gases entered the tubes before combustion was complete and the flame was extinguished.

In the Miles City plant the natural gas supplied to the furnace is controlled by a damper regulator. The steam pressure is maintained practically constant twenty-four hours a day. A recorder shows the CO_2 in the flue gas varies between 9 and 10 per cent, as compared to 11 per cent, the theoretical percentage of CO_2 obtainable with this gas. Flue gas temperatures ranging from 420 deg. at light loads to about 500 deg. F. at 250 per cent rating, justify the design of the boiler installation. Another point in the design definitely proved is the ability to operate the boiler up to 250 per cent rating on natural draft.

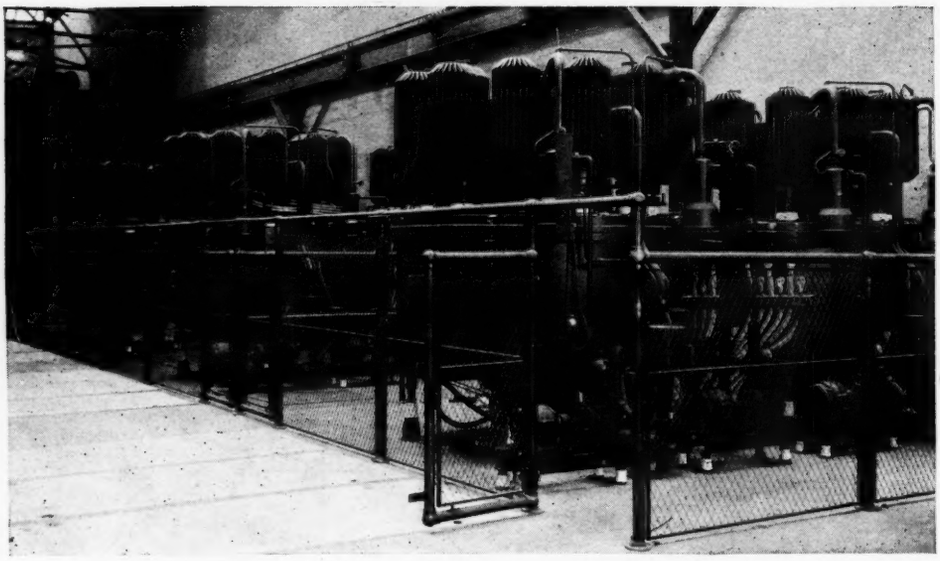
The plant is equipped with duplex, plunger-type, pot-valve feed pumps, steam-driven, which exhaust into the feed-water heater. The turbine, of the automatic bleeder type, is adapted to discharge steam to the heating steam,



Miles City 2,000-kw. steam plant and spray pond

and the feed-water heater, in turn is, connected to the heating system, so that any surplus steam from the auxiliaries will pass on to the heating system.

Water is scarce, so a spray pond is used for cooling the condensing water. This water contains approximately 110 gr. of sodium carbonate in solution, in itself an excellent boiler compound. Sodium carbonate being exceedingly soluble in water, there are no deposits in the boiler, although when the concentration reaches a point of about 1,200 gr. foaming begins. In the past the concentration has been kept in the neighborhood of 600 gr. in the boiler by blowing down. Arrangements are being made for the installation of a continuous blow-down system, because after three years' operation it has been found that such an installation is warranted.



Six 5,000-ampere, 460- to 560-volt mercury-arc rectifiers installed in the Canadian electrolytic zinc plant

By W. E. GUTZWILLER
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MERCURY-ARC RECTIFIERS Applied to Industrial Loads

Mercury-arc rectifiers have been used extensively to supply railway service and are now being applied on industrial and building direct-current power loads. An analysis is given of mercury-arc rectifiers' performance compared with that of synchronous converters and motor-generator sets

APPLICATIONS of mercury-arc rectifiers are not limited to supplying high-voltage direct current, even though the majority of rectifiers installed in this country are operated at 600 volts and higher for electric railway power supply. Their high efficiency at high voltages and ability to carry high momentary overloads are responsible for their general adoption for railway service. There are, however, many industrial applications at 500 and 250 volts direct current where mercury-arc rectifiers are economical.

For certain electro-chemical processes in this country mercury-arc rectifiers have been installed for voltages up to 9,600. One installation consists of a 2,200-kw. rectifier to supply direct current from 3,500 to 9,600 volts. In Europe 200- and 500-kw. rectifiers for 13,000 and 15,000 volts direct current have been installed in radio broadcasting stations.

In Europe, where mercury-arc rectifiers have been used for over fifteen years, besides being applied extensively in railway work, they are used on direct-current loads of large municipal light and power systems and for industrial plants. The Brown Boveri Company, Ltd., of Switzerland, has a total of over 1,200,000 kw. of rectifiers installed of which approximately 400,000 kw. is used on municipal direct-current systems and for industrial service.

Converting alternating into direct current for industrial purposes is generally done by motor generators and synchronous converters. Motor generators, due to their ease of voltage adjustment, are particularly suited to applications requiring a wide range of voltage control. They will operate more satisfactorily than synchronous converters under abnormal alternating-current line conditions. They are also better suited than converters to supply widely fluctuating loads and will withstand the direct-current short circuits often encountered in industrial railways, crane and hoisting service. A particular advantage of synchronous-motor direct-current generator sets is their power-factor correction feature. On the other hand, synchronous converters have a higher efficiency than motor-generators.

Mercury-arc rectifiers have a practically constant voltage drop for all loads and direct-current voltages. The arc drop for various types of rectifiers varies between 19 and 30 volts, the lower value being for small units and the higher for larger ones. Since the losses in rectifiers are proportional to the arc drop, it follows that smaller units are more efficient than the larger ones. This is the reverse of that for rotating-type converters, where the efficiency increases with increasing unit capacity. Since the rectifier's losses for a given type vary proportionally with the direct-current output, the efficiency is practically constant for all loads. The arc drop being independent of the rated direct-current voltage, rectifier efficiency will be higher the greater the direct-current voltage.

Figs. 1 and 2 show the efficiency curves of a 500-kw. synchronous-motor direct-current generator set, a synchronous converter and a mercury-arc rectifier as a

function of the load for both 250 and 500 volts direct current. To compare the three types of converters on the same basis these efficiencies were plotted without including the transformer losses, which are about the same for all three units. This holds true for above 6,600 volts alternating current. For lower voltages the motor-generator usually does not require a step-down transformer.

In industrial plants 250-volt direct current is generally used, while in electrolytic plants, steel and paper mills, and the larger industrial railroads 500 volts is frequently used. Fig. 2 indicates that at 500 volts the full-load efficiency of a synchronous converter and rectifier is about the same. At part loads the rectifier is more efficient. For higher voltages the efficiency rapidly increases in favor of the rectifier. For 250 volts, Fig. 1, the synchronous converter is more efficient than the rectifier above 50 per cent load. At lighter loads the

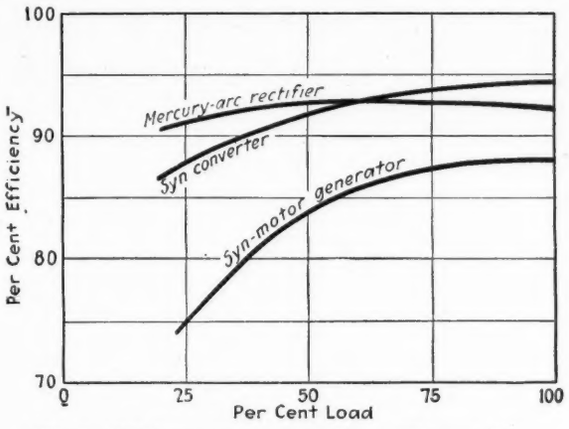


Fig. 1—Efficiency curves of 500-kw., 250-volt alternating-current to direct-current converting equipment without transformers

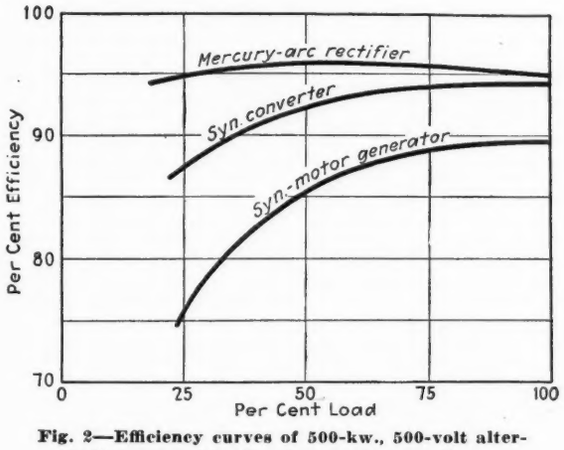


Fig. 2—Efficiency curves of 500-kw., 500-volt alternating-current to direct-current converting equipment without transformers

rectifier has an advantage. There is not very much difference, however, and it can generally be said that 250-volt synchronous converters and mercury-arc rectifiers up to approximately 3,000 amp. are about equal in efficiency. The motor-generator is less efficient for all loads.

Except for electrolytic plants, industrial loads are generally fluctuating. Converting units in 250-volt industrial service are usually rated between 100 and 1,000 kw. and consist of motor-generator sets. Up to about 750-kw. capacity the over-all efficiency of the 250-volt rectifier, including its transformer and auxiliaries, is about the same as for the synchronous motor-generator set without transformer. At part loads the mercury-arc rectifier is from 5 to 20 per cent more efficient. Fig. 3 gives comparative over-all efficiency, including transformer and auxiliary losses, of a 300-kw., 250-volt rectifier, and of a similarly rated induction and a synchronous motor-generator set without transformers. A primary supply of 2,300 volts, 3 phases, 60 cycles has been assumed. Based on these efficiency curves, the yearly power savings at different load factors derived from the rectifier in comparison with the synchronous motor-generator are given in the table.

The savings are calculated for a 300-day year, with a 10-hr. daily service, and also for a 365-day year, with 24-hr. service. The power is figured at the rate of 1 cent per kilowatt-hour. It will be noted, for instance, that with a 30 per cent load factor the yearly power savings based on a 10-hr. day, 300-day year, after deducting cooling-water costs amount to $909. This saving capitalized at 12 per cent represents $7,500. Similarly for a 24-hr., 365-day service the yearly power savings amount to $2,650, corresponding to $22,000 when capitalized at 12 per cent. The savings will still be higher in case of a primary supply voltage above 6,600 volts where the motor-generator requires a step-down transformer. The figures show that with the 250-volt mercury-arc rectifier for medium and smaller sizes and

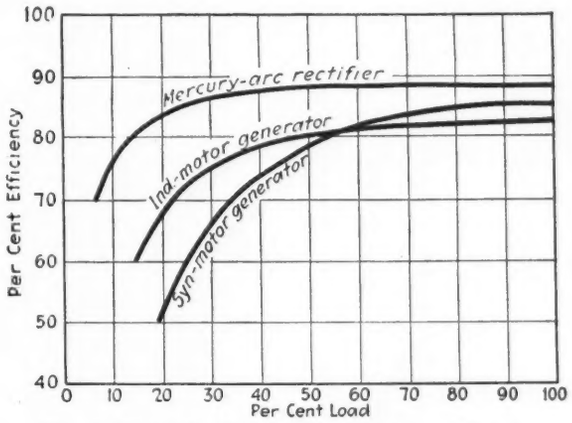


Fig. 3—Over-all efficiency curves for a 300-kw., 250-volt rectifier, a synchronous and an induction motor-generator set

in installations having 50 per cent load factor or less a substantial power saving can be obtained.

A mercury-arc rectifier's power factor at full load varies between 93 and 96 per cent, and depends on the type of connections of the rectifier transformer. (The values for power factor were inadvertently given as 91 and 94 per cent in a previous article, page 950, June 16 number, instead of 93 and 96 per cent.) The power factor is fairly constant betwen full load and about one-quarter load. It drops rapidly below one-quarter load and reaches about 80 per cent at one-tenth load. Since the power factor is not subject to adjustment, the rectifier cannot be considered for installations where power-factor correction is required. In this respect the mercury-arc rectifier is similar to the synchronous converter. Due to its flat power-factor characteristic, a power factor near unity will be obtained with rectifiers in spite of fluctuating loads and low load factor. Although rectifiers cannot furnish leading current, they have a corrective influence in industrial plants with a relatively low power factor. Since synchronous motors are being used for medium and large industrial drives,

many plants have sufficient synchronous capacity installed to take care of power-factor correction. Hence, from the viewpoint of power-factor correction the addition of rectifiers to such plants will seldom be objectionable.

Due to the absence of synchronizing forces, commutators and brushes, rectifiers are capable of carrying very high momentary overloads. Repeated direct-current short circuits, if cleared by ordinary breakers, will not harm mercury-arc rectifiers.

Mercury-arc rectifiers have a drooping voltage characteristic, with 5 to 6 per cent regulation from no load to full load, according to type of transformer connection. For most applications this shunt characteristic is desirable. It assures inherently stable parallel operation of two or more units in the same station and proper division between substations. The drooping characteristic is of particular value in stations carrying a fluctuating load and also for parallel operation of automatic substations. The latter requires special regulating equipment for satisfactory parallel operation in case of flat or overcompounded voltage characteristic.

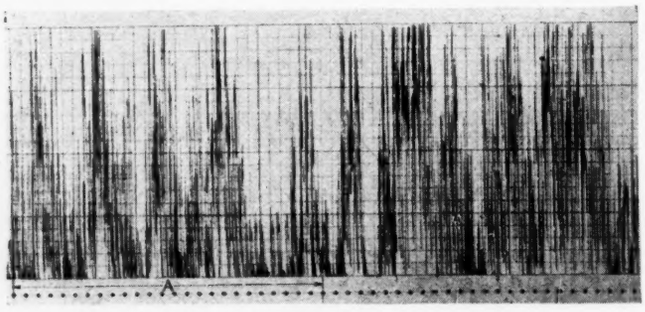


Fig. 4 — Direct-current load chart from a 700-kw., 500-volt rectifier supplying power to a coal and ore loading bridge, previously operated from two 55-kw. induction-motor direct-current flywheel generator sets. *A* represents one hour operation. The instrument could record 700 kw. only, but indicating meters showed that the peaks reached 1,200 kilowatts

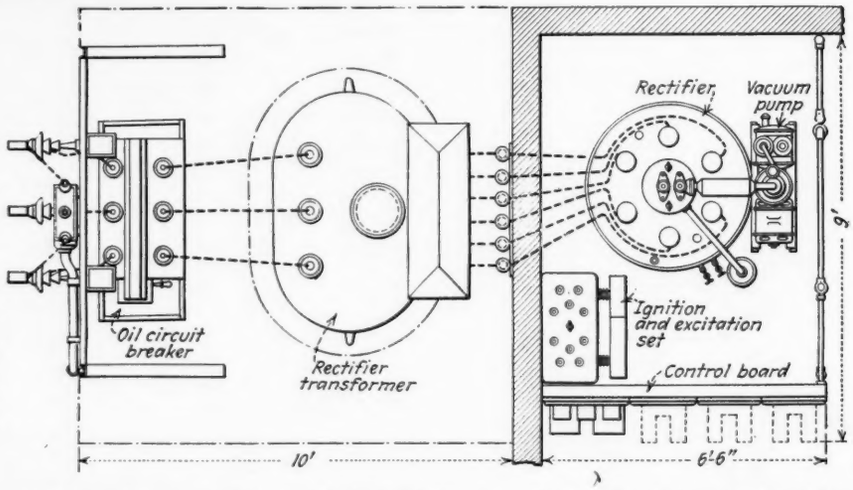


Fig. 5—Typical layout of a 300-kw., 250-volt rectifier substation in an industrial plant. The alternating-current supply is 13,200 volts, 3-phases, 60 cycles, and connects to outdoor switch and transformer equipment

There is a fixed ratio between the alternating- and the direct-current voltage of a rectifier. To vary the direct-current voltage it is necessary to change the impressed alternating-current voltage.

Changing taps on the primary winding of the transformers is the most practical way of adjusting the direct-current voltage of rectifiers. In the majority of installations no-load ratio adjusters are provided on rectifier transformers. They serve for compensating seasonal changes in supply voltage and to adjust the full-load voltage of the rectifiers to normal value. Where voltage adjustment under load is required, load tap-changing equipment will have to be provided on rectifier transformers. This refinement, however, increases the first cost of the rectifier equipment.

No difficulty in paralleling mercury-arc rectifiers with synchronous converters or motor-generators is encountered as long as the sets to be paralleled have substantially the same voltage regulation. Since the frequency of the alternating-current supply does not affect a rectifier's operation, there is also no difficulty in paralleling rectifier sets fed from networks having different frequencies.

Starting and stopping rectifiers are simple operations, and compare with switching in and out a transformer bank. Starting consists of energizing the ignition and excitation circuit, closing the alternating- and direct-current breakers and starting the cooling water. By an electrically operated valve the cooling water can be automatically turned on by an auxiliary contact on the rectifier's alternating-current breaker. The ignition-excitation apparatus may be energized automatically in a similar way. A rectifier's starting operation, then, consists merely of closing the circuit breakers.

Rectifiers are generally protected against overloads, excess cylinder temperatures and water and vacuum failures. Because of the few protecting features required and their simple starting, rectifiers are especially suited to automatic control.

For small additional cost a manually operated rectifier can be made semi-automatic by providing automatic control of the vacuum-pump set and by adding a temperature regulator for the cooling water. If automatic reclosing of the circuit breakers is provided the rectifier will operate automatically after it is started by remote push-button control. If tripped due to overload the breakers will reclose a number of times at predetermined intervals. After the last unsuccessful reclosure the rectifier will lock out and an alarm will be sounded. Full automatic starting and stopping of the plant may be obtained by the addition of a time switch or load-responsive control apparatus.

Floor-space requirements of a 250-volt rectifier with transformer are about the same as for a synchronous converter with transformer of equal rating. Up to 6,600 volts the motor-generator does not usually require a step-down transformer, and the floor space required is only 75 to 85 per cent of that for a synchronous converter or a rectifier. When a transformer is used with motor-generators they need from 30 to 40 per cent more floor space than rotary converters and rectifiers of the same rating.

The over-all weight of synchronous converters and rectifiers at 250 volts is greater than for motor-generators except when transformers are used with the latter. At 500 volts and higher the rectifier weighs considerably less than either the synchronous converter or motor-generator, and requires less floor space.

ESTIMATED ANNUAL POWER SAVING OF 300-KW. 250-VOLT MERCURY-ARC RECTIFIER COMPARED WITH A SYNCHRONOUS-MOTOR-GENERATOR SET

Load factor, per cent	20	30	40	50
Direct-current output, kw	60	90	120	150
Rectifier efficiency, per cent	84	86	87.5	88
Syn.-motor-gen. eff., per cent	52½	66	74½	78.8
Rectifier input, kw	71.5	104.5	137	170.5
Syn.-motor-gen. input, kw	114	136	161	190
Power saving, kw	42.5	31.5	24	19.5
Kw.-hr. saving per 10-hr. day	425	315	240	195
Kw.-hr. saving per 300-day year	127,500	94,500	72,000	58,500
Saving at 1c. per kw.-hr.	$1,275	$945	$720	$585
Yearly cooling water, cu.ft.*	27,000	36,000	46,000	56,000
Cost of water at $1 per 1,000 cu.ft.	$27	$36	$46	$56
Net yearly saving	$1,248	$909	$674	$529
Savings capitalized at 12 per cent	$10,400	$7,500	$5,600	$4,000
Net yearly saving for 24-hr. 365-day service	$3,650	$2,650	$1,970	$1,540
Capitalized at 12 per cent	$30,400	$22,000	$16,400	$12,800

*Includes cooling water for vacuum pump.

For installations where noise and vibrations of rotating machines are objectionable, as in office buildings, hotels and hospitals, rectifiers save the cost of housing of noise-absorbing materials and cork layers in foundations that are usually required for rotating-type converters.

Because of their static character, rectifiers do not require special foundations. Since a large part of the electrical losses are carried away by water, no special provision for substation ventilation has to be made.

Rectifiers' insulation exposed to atmosphere usually consists of smooth-surfaced porcelain insulators, so they are practically immune to the acid and metal fumes, dust and moisture frequently encountered around steel and paper mills, foundries, electro-chemical and metallurgical plants. Rotating-type converters installed in such localities require, as a rule, expensive air-washing and conditioning equipment. It is possible to install rectifiers in the same building or room where direct current is used, thus avoiding unnecessary feeder losses.

Fig. 5 shows a typical layout of a 300-kw., 250-volt rectifier unit in an industrial plant. The alternating-current supply, of 13,200 volts, 3 phases, 60 cycles, is brought in underground. All high-tension equipment is outdoor. The space required for the rectifier cylinder, its auxiliaries and control board is 6.5x9 ft., and for the high-tension outdoor equipment 9x10 ft., making a total floor space of 9x16.5 ft. For a 2,300 or 4,400-volt alternating-current supply all the rectifier equipment could be installed indoors in a total floor space of about 11x9.4 feet.

As previously explained, starting a rectifier consists mainly of connecting the unit to the power supply and to the load. The valve action of the rectifier prevents its having the direct-current voltage built up with wrong polarity. When operating rectifiers in parallel an incoming unit takes its share of the load and no adjustments are necessary. Equal load division between parallel-operated sets is assured even under adverse load conditions. Skilled operators are not required. After a failure of the alternating-current service the direct-current power may be restored simultaneously with the restoration of the power supply. Absence of synchronizing forces and rotating masses in rectifiers makes them unusually stable during line disturbances. They will operate safely on reduced frequency, alternating-current voltage and phase unbalance. On alternating-current systems, after a power failure, normal frequency and voltage are not always restored immediately. Under such conditions it may not be possible to start motor-generators and synchronous converters. Low cost of automatic rectifier control, low substation cost, the stability of rectifiers in parallel operation, and their high efficiency at light loads suggests the use of automatic rectifiers, particularly for multiple-station systems.

Rectifiers have no parts subject to wear, such as commutators, brushes, bearings, and therefore require little attention. According to the records of one of the largest users of rectifiers in this country, their maintenance cost, based on a yearly kilowatt-hour output, is approximately one-half of that for synchronous converters. Where water of improper quality is used for cooling rectifiers, deposits and corrosions may occur in the cooling jackets, which will require occasional cleaning and painting. Rectifiers are designed so that this cleaning can be easily done and without breaking the vacuum.

At direct-current voltages of 500 volts and higher mercury-arc rectifiers show advantages over the motor generators and synchronous converters under practically all conditions. For 250-volt industrial service, rectifiers are more economical than synchronous converters or motor-generators where a large range of direct-current voltage control under loads is not required; also where the alternating-current supply voltage is above 6,600 volts; where power-factor correction is not required; where unit capacity does not exceed about 3,000 amperes; where the daily load factor is 50 per cent or less; and where electric remote, semi-automatic or full-automatic control is required.

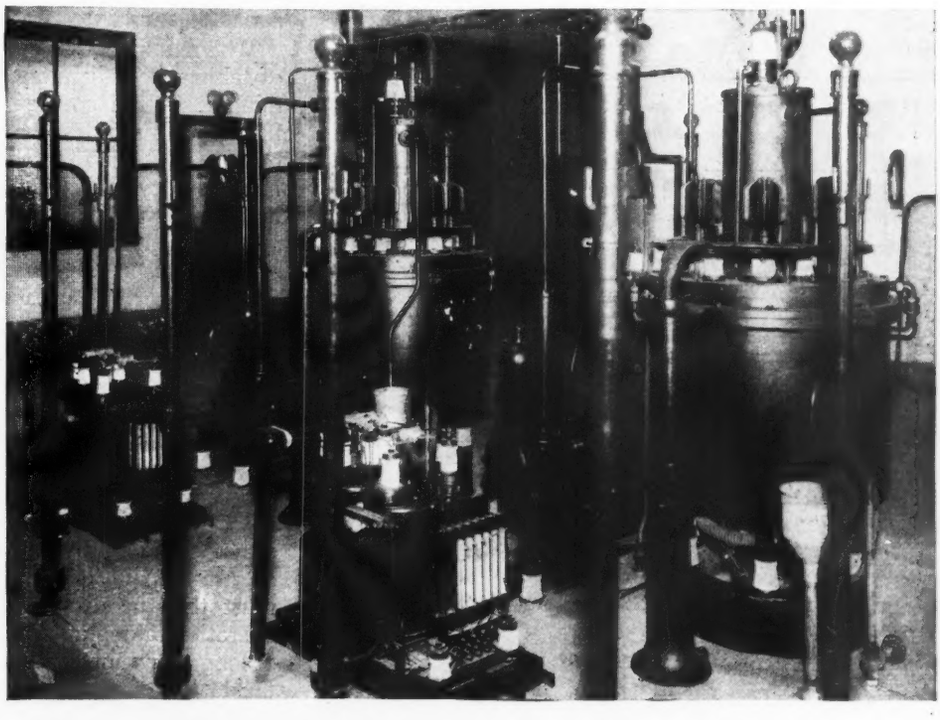


Fig. 6 — Two 132-kw., 500-amp. 265-volt manually controlled mercury-arc rectifiers installed in the basement of a department store and supplying a load of 15 elevator motors and other building motors

Gage-Glass Readings May Belie True Water Level

Do you know where the water level is in your boilers? If you have a "half glass" of water, have you a half drum of water? You may trust your gage glass at boiler drum pressures of 600 lb. or less, but there is reason to believe that the gage glass may be considerably in error when boiler pressures of around 1,200 pounds are reached

By EDWIN H. KRIEG
Engineer Mech. Div. of Electric Bond & Share Co.
New York City

INACCURACY of water gages is peculiar to high-pressure boilers carrying pressures of around 1,200 lb., and there is reason to believe that many troubles may result therefrom. In many high-pressure plants we hear of deposits in superheaters and on turbine blading. That there is a close relation between boiler carryover and the water level in the drum is clearly shown in the June, 1930, N.E.L.A. report on treatment of feedwater. In this report, New Orleans Public Service, Inc., gives the results of a number of tests, and draws the conclusion that for its conditions "regulation of water level is of extreme importance and the water level should be carried at 5 in. or less in the glass." This corresponds to 2½ in. below the drum centerline for the boilers tested. Fig. 1 is reproduced from this report.

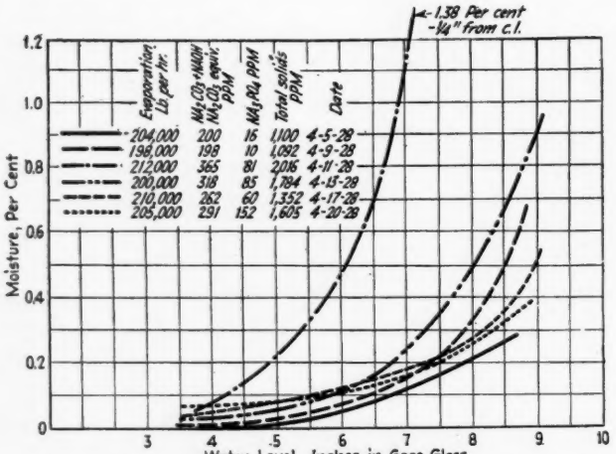

1.38 Per cent
-¼" from c.l.
Evaporation Lb. per hr.
NaOH ppm
Total solids ppm
Date
204,000 200 16 1,100 4-5-28
198,000 198 10 1,092 4-9-28
212,000 365 81 2,016 4-11-28
200,000 318 85 1,784 4-13-28
210,000 262 60 1,352 4-17-28
205,000 291 152 1,605 4-20-28
Moisture, Per Cent
Water Level, Inches in Gage Glass
Water Level, Inches from C.L. of Drum

Fig. 1—Moisture in steam with different water levels

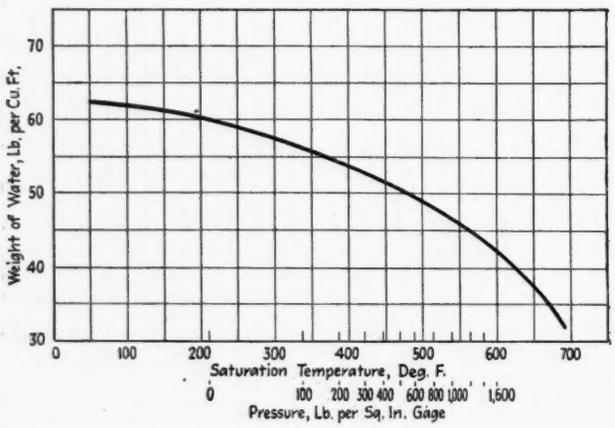


Fig. 2—Variation of weight of water with temperature

Of course, high boiler-water concentrations of over 1,400 p.p.m. will also increase carryover, but the point is clear that high water level (above the centerline of the drum) will greatly increase the amount of carryover with accompanying deposits in the superheater and turbine.

The statement by New Orleans Public Service, Inc., is also substantiated by a statement in the same report of the Commonwealth Edison Company, which reviewed a series of similar tests at the Crawford Avenue station.

By minimizing superheater tube maintenance, the cost of taking the boilers out of service is also decreased. By minimizing the cost of cleaning deposits from turbine blading and nozzles, the inconvenience of taking turbines out of service is reduced and the rate of decrease of turbine capacity caused by the deposits is diminished. This latter point is of no mean importance. In the August, 1930, N.E.L.A. report on turbines the Southern California Edison Company gave a curve showing a decrease in turbine capacity from 106,000 kw. to 99,000 kw., or 6.6 per cent in three months, due entirely to deposits on turbine blading. This company states that a 10 per cent decrease has also been suffered. This experience is far from being unusual, especially in high-pressure stations, as numerous articles in the technical press have shown. In many stations various expedients have been resorted to in an endeavor to remedy the effects of boiler carryover, such as by introducing water into the steam going to the turbine for several hours until the saturation point is nearly reached. The quantity of water must then be decreased over several hours, the entire operation taking about 12 hr., depending upon conditions. A longer or shorter time may be necessary. But why not tackle the source of the trouble instead of the results,

or at least, one of the probable sources—that of boiler-water level.

It must be remembered that correct water level may not be a cure-all, but at least if we can be sure that the level in the drum is correct, one source of trouble has been eliminated and attention may then be concentrated on feed-water treatment or other possible causes. The variation in the weight of water at various temperatures is shown in Fig. 2.

If we have a U-tube with one leg filled with water at 591 deg F. (saturation temperature corresponding to a drum pressure of 1,435 lb. gage) weighing 42.2 lb. per cubic foot,[1] and the other leg filled with water at 150 deg. F., weighing 61.2 lb. per cubic foot, 10 in. of the cooler water will balance 14.5 in. of the hot water.

With a boiler drum and a gage glass, we have the condition illustrated in Fig. 3. The weight of the steam, which at 1,435 lb. is considerable, is balanced in the

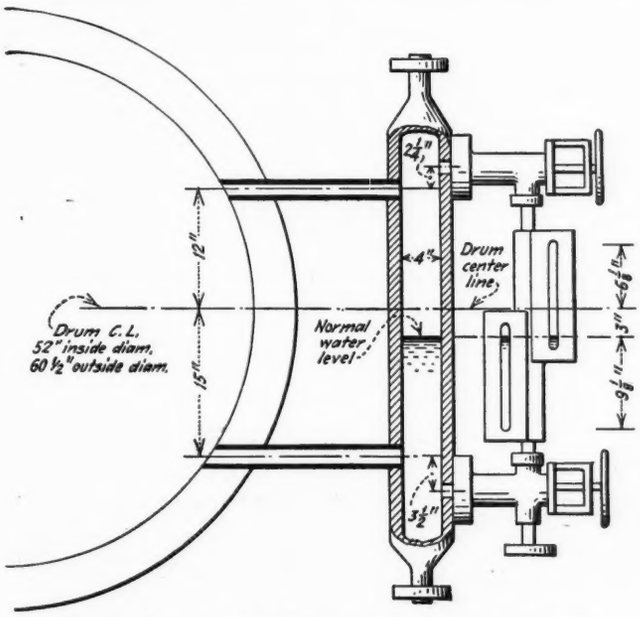


Fig. 3—Actual water column and gage-glass layout for a 1,435-lb. boiler

drum and gage glass because the height of the steam column above the two water levels is substantially the same, except for the actual difference in the water levels due to difference in density caused by their difference in temperature. The dimensions in the figure were taken from an actual boiler recently installed that will carry 1,435 lb. gage pressure in the drum. The boiler manufacturer set the condition that the level in the gage glass must be 3 in. below the center drum line under all conditions of boiler output and pressure. Until the 1,290-lb. turbine is installed, the two boilers in this plant are being operated under 365 lb. pressure.

The level in the drum corresponding to the normal gage-glass level 3 in. below the drum center line may easily be determined for a 150 deg. F. gage-glass temperature as in the following typical computation:

$$12 \text{ in.} \times \frac{61.2 \text{ (wt. at 150 deg. F.)}}{42.2 \text{ (wt. at 590 deg. F.)}} = 17.4 \text{ in}$$

Thus the water level in the drum will be 5.4 in. higher than in the gage glass. If the relation between carryover and water level for 1,435 lb. pressure is similar to the curves in the statement by New Orleans Public Service, Inc., it is easily seen that these 5.4 in. may be all the difference needed to cause excessive carryover.

But how do we know that the temperature of the water in the gage glass is going to be 150 deg. F.? We don't. I have never seen any published figures on gage-glass water temperature, and even if they are available it is questionable whether a gage-glass water level can be predetermined and held by the water tender.

Without doubt the gage-glass water temperature is subject to variation. Causes of this variation may be air currents set up by open windows or other ventilation, blowing down the glass, the taking of water samples, etc. Of course, this variation may be minimized by placing the water column and gage glass close to the drum, lagging the water piping, and leaving the steam piping bare. This will tend to condense as much steam as possible, thus keeping the water in the glass closer to saturation temperature, and the lagging on the water piping will help to maintain that temperature. The condensation of the steam will also assist in producing a degree of circulation in the gage and its connecting piping. It may thus be seen that either leaving the gage glass and all its piping bare or a totally lagged insulation would probably not be so successful as the partly lagged, partly bare job.

A word of caution may be given here as to placing the gage glass at some distance from the drum, such as is often done when the firing aisle is at the uptake end of the boiler and the water gage is placed some 25 or 30 ft. from the drum in order to have it visible from the firing aisle. Although more steam may be condensed, thus tending to keep the water temperature high, the heat losses in the water piping will also be greater. So far as is known, however, there are no data available as to whether the error would be greater or less than if the water columns were near the drum. However, on high-pressure boilers certain boiler manufacturers recommend placing the gage as near to the drum as possible. The percentage error for various gage glass temperatures is shown in Fig. 4 for several drum pressures.

The error may also be shown in another manner. Fig. 5 is a series of curves that represent 1 in. of water in the boiler drum. The abscissas show drum temperatures and corresponding pressures; the ordinates show the equivalent height of water in the gage glass for gage-glass temperatures indicated on the curves. Thus for a drum pressure of 1,435 lb. gage and a corresponding drum water temperature of 590 deg. F., and using curve for a 150 deg. F. gage-glass temperature, the ordinates give a height of 0.69 in. of water in the gage

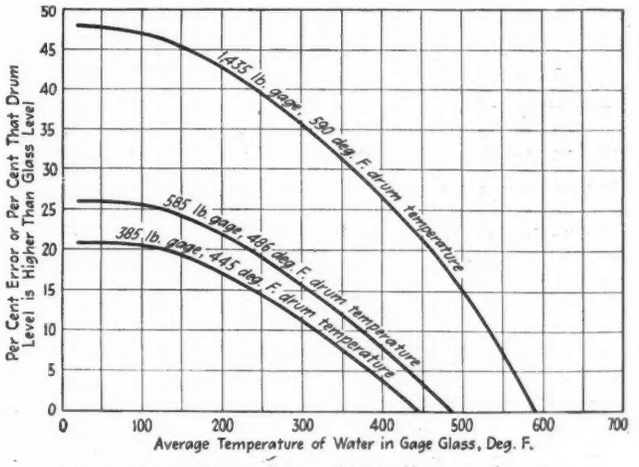


Fig. 4—Per cent error with different gage-glass temperatures and drum pressures

[1]Based on specific volumes of water in Keenan's Steam Tables.

glass for each 1 in. of water in the drum. If there is 12 in. of water in the glass, there will be 12 in. ÷ 0.69 = 17.4 in. in the drum. Fig. 5 also shows the comparatively small error for drum pressures of less than 600 pounds.

The condition is also aggravated by the probability that the drum level is higher than the water gage level from two other causes: (1) the drum water has steam bubbles entrained in it, lowering its density below that of the water in the glass; (2) there is reason to believe that the level in the center of the drum is higher than at the ends, due to the higher temperature of the central portion of the gases. The second condition is also affected by the water-wall circulation, point of injection of feed water, etc.

Although the possible variation of the gage-glass temperature may be minimized by placing it close to the drum, leaving the steam piping bare, and lagging the water piping, we are still confronted by the variation

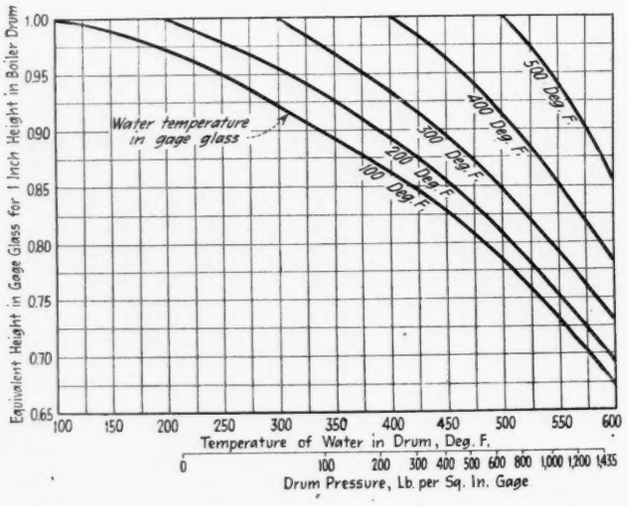

Equivalent Height in Gage Glass for 1 Inch Height in Boiler Drum
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
Water temperature in gage glass
500 Deg. F.
400 Deg. F.
300 Deg. F.
200 Deg. F.
100 Deg. F.
100 150 200 250 300 350 400 450 500 550 600
Temperature of Water in Drum, Deg. F.
0 100 200 300 400 500 600 800 1,000 1,200 1,435
Drum Pressure, Lb. per Sq. In. Gage

Fig. 5—Height of water in gage glass for different drum pressures and gage-glass temperatures

caused by air currents and other factors. Pending the time when the means of maintaining a constant temperature becomes known, thus permitting predetermination of the gage-glass level for all conditions of operation, there should be available to the water tender a chart showing what level he should hold for varying temperatures and boiler outputs. This may be a curve sheet similar to Fig. 4, but as it only takes into consideration the effect of temperature, the effect of water concentration must necessarily be determined and corrected for the individual plant, such as was done by New Orleans Public Service, Inc. Fig. 5 should therefore be extended by the addition of a series of curves for various concentrations. Also, instead of giving only the height in the gage glass corresponding to 1 in. in the drum, the exact gage-glass height should be given to eliminate computation. Fig. 6 shows such a curve sheet.

The only instrument required to enable the water tender to keep the proper level is a thermometer, which may be located in the gage-glass piping where convenient.

It is realized that with only one thermometer an average gage-glass temperature will not be obtained. Obviously, a certain amount of correction is necessary.

In addition the plant chemist must also supply the water tender with the boiler water concentrations from time to time, although with a proper blowdown schedule the concentrations can probably be guessed at quite accurately after a few trials.

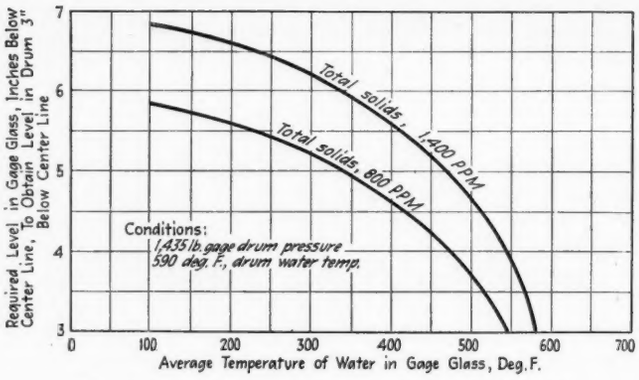

Required Level in Gage Glass, Inches Below Center Line, To Obtain Level in Drum 3" Below Center Line
7
6
5
4
3
Total solids, 1,400 PPM
Total solids, 800 PPM
Conditions:
1,435 lb. gage drum pressure
590 deg. F., drum water temp.
0 100 200 300 400 500 600 700
Average Temperature of Water in Gage Glass, Deg. F.

Fig. 6—Gage-glass water level to be maintained

When it is realized that much time, expense and labor, involved in removing deposits from superheaters and turbines may be saved, this additional procedure may become easily justifiable. In addition, outage of boilers and turbines may be reduced, and when an expensive installation is made it is not desired that its capacity be reduced 15 per cent. If figures as to the increase in steam consumption of turbines due to deposits were available, it might be found that a relatively large amount of money could be expended for remedial measures.

In conclusion, it must be realized that this discussion is under the handicap of having no actual figures as to water gage temperatures. It is the writer's earnest hope that some operating company will realize the possibilities afforded by such determinations and will make such figures available to those who have not the necessary facilities.

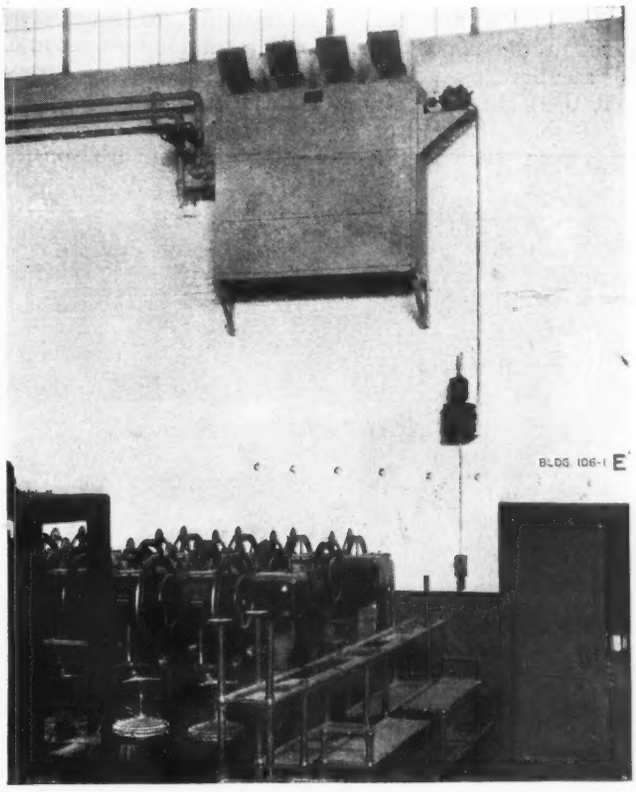
▼

RHAPSODY IN STEEL

THIS "piano" type control keyboard was designed by the General Electric Company so that one person can easily control a large number of auxiliary mill drives. The easily manipulated foot pedals cause two large motors totalling about 10,000 hp. to reverse from full speed in one direction to full speed in the other direction in less than two seconds.

Unit Heaters Prove Economical in Large Single-Area Building

Cost of electric current and maintenance of fans and motors amounts to less than 60 per cent of the fixed charges on the additional investment that would have been required for direct radiation. In operation, temperatures at various elevations from the floor are exceptionally uniform. In the upper portion of the building temperatures 27 deg. lower than would have obtained with direct radiation indicate a reduction in heat loss equivalent to 1,740 tons of coal per season



Unit heaters placed 22 ft. 4 in. above the floor discharge heated air at velocity of 1,800 ft. per min.

By W. R. LOVELESS

Engineer
Western Electric Company

UNIT HEATERS have been used successfully for heating one of the largest single-story structures in the world, in point of open floor area, in the installation made in the main cable plant building at the Hawthorne works of the Western Electric Company. This building is 300 ft. wide in three 100-ft. bays, 733 ft. long, and approximately 37 ft. high to the roof. The length extends north and south.

This building has heated areas adjacent to it on the east and west, these adjoining buildings averaging approximately 18 ft., in height, so that the cable plant building has exposed walls extending above them. The exposed walls contain approximately 51, 43, 30 and 35 per cent glazing, respectively, on the east, north, west and south sides. The roof trusses are of structural steel, 100 ft. span at 33⅓-ft. centers, supported by two center and two wall columns. The east and west side walls are cut through considerably by doorways and passageways to adjoining buildings, and trucking aisles were planned adjacent to the side walls. These conditions had considerable bearing upon the final decision concerning the type of heating system to adopt.

In general, hot water is used as a medium for heating the other buildings at the Hawthorne works, the supply being circulated by pumps from a central power station, where exchangers are located to utilize the heat in the exhaust steam from station auxiliaries. The temperature of the circulated water is centrally controlled to suit outside atmospheric conditions, and excess exhaust steam is utilized in mixed-pressure turbines for production of electric power. These same turbines supply, by extraction, such additional low-pressure steam as may be required to meet extreme cold-weather conditions.

With ample low-pressure steam available, and as existing hot-water circulating mains to the cable plant were of sufficient size to carry the additional load imposed by the new building, it was desirable to make use of available facilities. Preliminary considerations of various heating methods indicated that the decision must be made between the use of direct radiation and so-called "unit heaters," as the only systems that could be installed without interference with manufacturing processes.

The special field of the unit heater appeared to be in heating large spaces of considerable height where it is difficult to maintain a comfortable temperature in the occupied zone without greatly overheating the upper portion of the building. In buildings heated by fixed radiation near the floor level it is not uncommon to have a temperature variation of 2 per cent per foot of height. One of the chief advantages claimed for the unit heater was its ability to hold down temperature in the upper part of the room and place the heat near the floor, where needed, thus reducing the heat transmission loss through the roof and upper side walls.

A temperature of 65 deg. F. was desired in the cable plant buildings at a plane 5 ft. above the floor when the outside temperature registered zero deg. F. Under these conditions, with direct radiation, the temperature just below the roof might be $(37 - 5)\ 0.02 \times 65 + 65$

= 107 deg. F. With unit heaters the temperature just below the roof was assumed to be about 80 deg. F., and tests made after installation proved that this assumption was approximately correct. Therefore, by using unit heaters, the temperature at the under side of the roof would be lowered 27 deg. F., or from 107 to 80 deg. F. On this basis, the reduction of heat losses through the upper roof, monitors and upper portions of the building walls was calculated to be more than 4,900,000 B.t.u. per hour, equivalent to approximately 1,740 tons of coal per season. This is an appreciable item even when the value of the heat is figured on the basis of the value of exhaust steam from the production of electric power.

Another result claimed for unit heaters, and subsequently confirmed by experience, is that the slow movement imparted to the entire air content of the room will distribute quite uniformly the warm air and return the cooler air to the heaters without churning or producing unpleasant drafts. Direct radiation provides little air movement. Furthermore, with the unit heater, circulation of the air is possible at all times, for the temperature of the circulating hot water can be, and is, regulated at the central plant to vary with outside temperatures, thus permitting continuous operation of the unit-heater fans without creating excessive room temperature. Also, in warm weather, the fans on the unit heaters can be rotated and thereby produce air movement that will tend to alleviate discomfort from prevailing high temperatures. In view of the foregoing, the choice was distinctly in favor of employing unit heaters.

Advice from suppliers was to the effect that the maximum range of effectiveness of the unit heaters selected was 180 ft. from the outlets, and as the building is 300 ft. wide and heaters on both walls were planned, the installation came close to the limiting maximum. The three 32-ft. wide monitors caused additional concern, since no direct radiation was planned in them to counteract their chilling effect upon warmed air in its passage from the heater outlets to the center of the building. Nevertheless the original decision was followed, since direct radiation could be installed in these monitors at any future time that it seemed advisable. Results of operation have not shown the necessity for such additions.

Calculation of heat loss of the building indicated that with an outside temperature of zero deg. F. and an inside temperature of 65 deg. F. at 5 ft. above the floor, the total loss would be 10,400,000 B.t.u. As the building consisted of 22 bays in length, it seemed desirable, to obtain uniformity of appearance, that the number of units supplying this heat be a multiple of 22. It was found that a suitable standard unit could be obtained, which was rated at 274,000 B.t.u. when supplied with water at 190 deg. F. This unit circulated 5,480 cu.ft. of air per minute at a discharge velocity of 1,800 ft. per minute. It was decided to locate one unit in each bay, or 22 on each side wall, making a total of 44.

View of main cable plant of the Western Electric's Hawthorne plant showing unit heaters placed on each side wall

It was decided to install the unit heaters at a relatively high elevation to avoid interference with manufacturing equipment and trucking aisles. This was a radical departure from the customary practice at that time and doubt was expressed as to the satisfactory delivery of the heated air at the breathing zone in the middle of the building. However, the outlet nozzles on the heaters were placed approximately 22 ft. 4 in. above the floor and were deflected somewhat downward to overcome the natural buoyancy of the warm air and bring it to the desired level. It was believed that more satisfactory air conditions would be obtained than from heaters installed at the floor level, with blasts of warm air sweeping across the room close to the breathing line, particularly with a discharge velocity approximating 1,800 ft. per minute. The higher location also offered a small additional saving in installation cost, owing to the shorter pipe connections required.

To serve the unit heaters, supply and return mains of standard black wrought-steel pipe were located above the bottom chord of the roof trusses to form loops inside of the building about 15 ft. from the walls. These loops each contain two expansion bends on each side and one in the closed end of the loop. The mains are welded throughout, using deflecting nozzles for branch connections instead of fittings. Reduction in size of pipe was obtained by swaging the pipe beyond a deflecting nozzle.

Located on 33⅓-ft. centers (one per bay) on the east and west walls of the building, the heaters discharge the air in vertical planes perpendicular to the walls. They were installed on brackets so located that the air intake of the unit is 15 ft. 7½ in. from the floor. Supply and return branches to each heater are taken off the bottom

of the mains near roof-truss locations and so routed to the heaters as to offer minimum obstruction to the windows. Automatic thermostatic control is installed for each unit, with push-button switches for starting and stopping.

Analysis of the installation indicates that the unit heaters were installed at a cost of somewhat less than 50 per cent of the estimated cost of direct radiation. The annual excess operating cost of unit heaters over direct radiation, that is, cost of electric current, repairs to and maintenance of fans and motors, amounts to less than 60 per cent of the fixed charges on the additional investment that would have been necessary for direct radiation. These fixed charges include interest at 6 per cent, depreciation at 5 per cent and taxes and insurance at 2 per cent.

This installation has been in service through three heating seasons, and its operation was watched closely during the severe winter conditions of 1929–30 and 1930–31. Readings taken within the building 30 ft. from each corner, when the outside temperature was 12 deg. below zero, gave temperatures of 73, 68, 69 and 61 deg. F., the last reading being affected by the main entrance vestibule, which was then insufficiently heated by direct radiation. Under the same outside conditions, the following temperatures taken at various elevations from the floor indicate an exceptionally uniform heating condition:

Distance above floor, ft. . .	5	7	9	11	13	15	20
Temperature, deg. F.	72	71	71	72	73	74	76

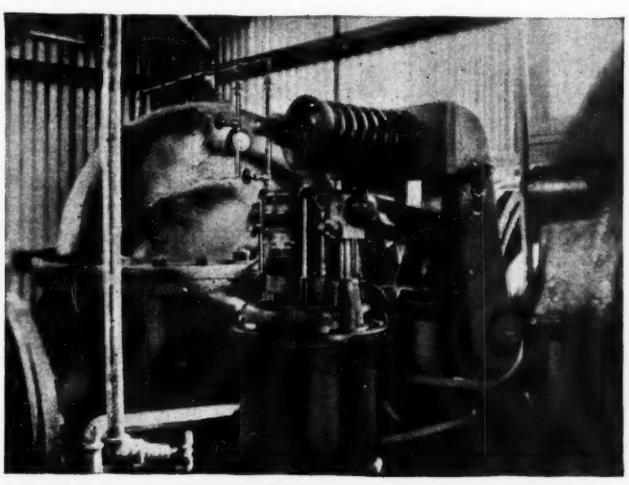
The results have been so satisfactory that similar systems have been installed in two smaller buildings subsequently constructed by the Western Electric Company.

▽

Check Valve on Pump Replaced by Magnet Brake

IN THE Montague Water Conservation District of California there is a 250-hp. motor-driven, direct-connected centrifugal pump at the Big Springs pumping plant. To prevent the water in the discharge line from reversing the pump on power failure and causing serious trouble from overspeed, a check valve was installed on the discharge side of the pump. This valve, however, caused an appreciable drop in pumping efficiency because of excess friction, and another method of accomplishing the desired result was sougth.

A General Electric thrustor, or electro-hydraulic operator, operating a magnetic brake, was installed. This brake holds the pump stationary on power failure and lets the water in the pipe line flow out gradually, with no surge disturbance.



Brake keeps pump from being reversed by the water when the power fails

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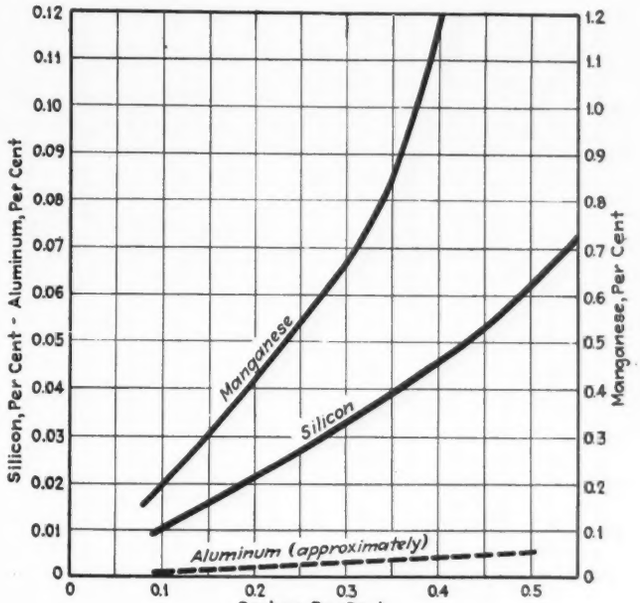
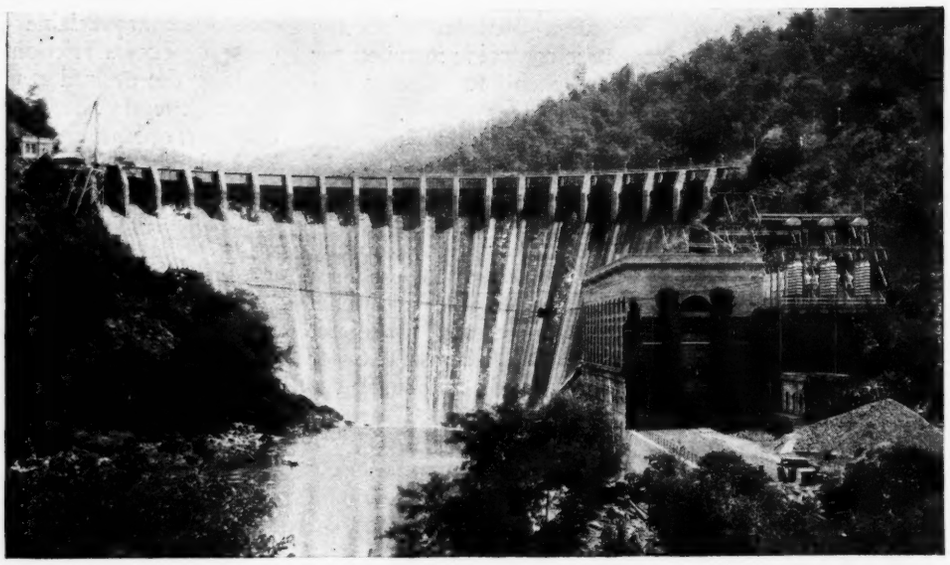
New Chart Specifies Composition of Weldable Steel

UNDER THE NAME "Lincoln-Stine Equilibrium Curve," a chart specifying the composition of steels which may be easily welded has been released by the Lincoln Electric Company. This chart, which is reproduced herewith, is based on research conducted by Wilmer E. Stine of the Lincoln Research Laboratories and formerly associate materials engineer with the United States Navy. It is stated that if, for a given percentage of carbon, the steel contains aluminum, silicon and manganese in the proportions shown by the curves, it will be easy to weld, and unlikely to exhibit porosity in the finished work. For example, if the steel has 0.20 per cent carbon, the indicated portions of other elements are: silicon, 0.021 per cent; manganese, 0.40 per cent; aluminum, not more than 0.002 per cent.



For each percentage of carbon the chart gives the proportions of manganese, silicon and aluminum for good weldability

With proportions according to the chart, there is said to be no chemical reaction, and hence little resulting porosity, when the temperature of the metal falls to a point only slightly above the temperature at which the steel solidifies. Even where the composition of the available steel is not in accord with the chart, satisfactory welds may often be made, according to the Lincoln announcement, by a corrective flux fused into the steel during the welding process.



Cheoah hydro-electric development on the Little Tennessee River, North Carolina

Organizing Hydro-Electric Inspection and Maintenance

By J. ELMER HOUSLEY
Superintendent
Tallassee Power Company

How an inspection and maintenance organization was developed to take care of a system that in a few years grew to a capacity of 286,000 hp. in 3 plants several miles apart

PERHAPS the idea that preventive maintenance should be adopted universally to cut repair costs is no longer a theory but rather a principle verified by the records of many hydro-electric plants. It would be interesting to know the extent to which this practice has been adopted. Little publicity was given this method of handling and preventing certain classes of equipment breakdowns until about ten years ago.

How a hydro-electric system handled its maintenance organization when expanding from 81,000-hp. capacity to 286,000 hp. may be of interest before taking up the details of how to make inspections, set schedules and adjust or overhaul hydraulic and electrical equipment.

In expanding the organization to cover three plants several miles apart, with long transmission lines and a telephonic dispatching plant, the operation and maintenance duties are immediately directed by an electrical engineer. His organization consists of a transmission engineer, two junior electrical engineers and a cooperative engineering student. In each plant a chief operator follows up a major portion of the routine work of both inspection and repair. One central crew of five mechanics makes the rounds of all power houses for scheduled maintenance and breakdowns, and this crew is augmented, when necessary, by two mechanics resident near the two smaller plants. There is a small number of miscellaneous laborers who fill out the crew for heavy rigging and as helpers.

A skeleton transmission-line crew is under the supervision of the transmission engineer. This crew provides line patrol and inspection work, and makes pole replacements, repairs and line extensions when necessary. Much rigging and labor work is handled by this crew in and about the power houses.

From the resident repairmen, one is selected for each power house to serve as a keyman to make the minor running adjustments and look after all special tools, repair parts, rigging supplies and gasoline engines at one plant. The camp plumbing, water and fire protection are looked after by the men.

The junior engineers inspect, test and repair meters, relays, regulators; run tests, make inspection of all equipment, follow up material on order, repair jobs, alterations in equipment and the record systems. Men not in the plant every day should be able to discover incipient troubles quicker than the operators, as the change in operating characteristics is sometimes slow.

The use of cooperative engineering students in the power plants and engineering offices has been satisfactory. Two students are assigned to the hydro-electric system. One student works three months in the plant while the other spends three months in school, and this

plan keeps one man on the job at all times. The system furthers an excellent educational plan and gives the student an early insight into what he will meet in the field. The students are moved from one job to another and cover all phases of the work.

All maintenance work about the camps, including dwellings, club house, store, recreation hall, motion-picture house, landscaping, water, lights and sewage system is budgeted and a certain amount of work is planned and executed each year. With a variety of work the men from the central maintenance crew have jobs suitable for all weather conditions and no large expenditures are incurred during a given period. These men are always available for emergency work in the power houses, and thus a large number of unoccupied men are not necessary in each plant to take care of such emergencies.

The operators and repairmen take pride in a plant kept in the best possible state of repair. A clean appearance is given by the use of aluminum paint on all building steelwork and interior steel of all description. A judicious use of color in the interior gives good vision and avoids monotony. All piping colors follow a code which simplifies operation. Under these conditions good housekeeping is practiced by the men without much persuasion. Interior painting may be kept in good condition for a long period of time by proper cleaning and touching up of damaged parts. Windows and glassware of fixtures and meters are washed in a solution of Oakite, from one-half to one ounce of the powder per gallon of lukewarm water. Where paint and grease is to be removed from any object, except aluminum parts, it is boiled in a solution of Oakite, one-half to three ounces per gallon. From 15 min. to 2 hr. will remove paints, including enamels, which require the longer time. Discolored brass parts, such as fan blades, copper switches and other parts, when thus cleaned and relacquered, give the appearance of new equipment. On the concrete and tile floor, the solution is used hot to remove grease and oil stains.

All automobiles and trucks are greased once a week and are given a general inspection and adjustment once a month. An inspection sheet is filled out by the repairman, giving the condition as found and the work done, following the inspection sheet used successfully by some time by Franklin automobile service stations.

Sample Color	Contents of Pipe	Sample Color	Contents of Pipe
Moss Green	Water Pipes, *Pressure*	Dark Brown With Red Fittings	Governor Pipes, *Return and interconnecting lines at low pressure*
Moss Green With White Fittings	Water Pipes, *Return*	Black	Governor Pipes, *Oil or water drain lines into sump or tail race*
Yellow	Lubricating-Oil Pipes, *Pressure*	Red	Gasoline Pipes
Yellow With Red Fittings	Lubricating-Oil Pipes, *Return*	Maroon	Air Pipes, *Pressure*
Buff	Transformer-Oil Pipes, *Pressure*	Aluminum	Conduit Pipes
Buff With Red Fittings	Transformer-Oil Pipes, *Return*	Gray	Exhaust Pipes, Air or Gas
Dark Brown	Governor Pipes, *Pressure*	Same as Walls	Roof Drains

All piping is painted according to this color code

Report No. ..... Company ..... Date .....

MONTHLY INSPECTION REPORT

For: Service Car ..... Truck ..... Boat ..... Stationary Engine .....
Type: Car ..... Boat ..... Location ..... Model .....
License Number ..... Speedometer Reading .....
Oiled By ..... Inspected By .....

CK.	OIL AND GREASE	USE	REMARKS
	Front hub caps	Grease	
	Steering ball joints	Grease	
	Spring pivot bolts	Grease	
	Front axle pins - right	Grease	
	Front axle pins - left	Grease	
	Steering device	F. grease	
	Hand brake hand lev. shaft	Grease	
	Hand brake lever shaft	Grease	
	Foot throttle shaft	Eng. oil	
	Clutch trunnion bearing	Eng. oil	
	Transmission	Trans. lub	
	Differential	Trans. lub	
	Universal joints	Trans. lub	
	Rear wheel bearings	Grease	
	Rear axle housing	Lub.	
	Ignition instrument	Light oil	
	Generator bearing	Light oil	
	Bendix drive	Eng. oil	
	Water pump	Grease	
	Prop. shaft bearings	Eng. oil	
	Speedometer shaft	Eng. oil	

Tire pressure: R.F. ..... L.F. ..... R.R. ..... L.R. ..... Spare .....

CK.	PART	REMARKS
	Clean motor	
	Spark plugs	
	Valves	
	Ignition system	
	Generator	
	Starter	
	Engine base oil	
	Compression	
	Carburetor vacuum tank	
	Gascolator	
	Horn	
	Steering device	
	Lighting system	
	Fr. wheel bearing	
	Fr. wheel alignments	
	Fr. axle yoke pins and bush.	
	Rim lug nuts	
	Front springs	
	Steering connections	
	Rear springs	
	Shock absorbers	
	Rear axle shaft	
	Universal joint	
	Body bolts	
	Brakes	
	Clutch	
	Battery	
	Water pump	
	Cooling system	
	Prop. and shaft	
	Interior	
	Operating tests	

General remarks:

Monthly inspection report form for automotive vehicles, motor boats and stationary internal-combustion engines

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Paris Refuse Incinerator Generates Byproduct Power

By JULES COLON

DESTRUCTION of refuse of the city of Paris, France, is handled by four suburban plants, at St. Ouen, Issy-les-Moulineaux, Romainville and Ivry. Incineration is not the only object of these plants. The heat recovered from the refuse generates over 70,000,000 kw.-hr. per year. Among other byproducts the resulting clinker supplies concrete aggregates and a raw material for brick manufacture.

Composition of refuse varies with the locality and the season. The variation is such that a successful treatment in one place may prove a failure elsewhere. After several years of research, the following figures were determined for use as a designing basis.

Heat value, B.t.u. per pound, as fired:

Maximum in March	4,000
Minimum in September	2,700
Yearly average	3,400

Moisture content, per cent:

In summer, when the amount of vegetable refuse is high	55
In winter	25
Yearly average	40

Ash content, per cent:

Summer	34
Winter	43
Yearly average	39

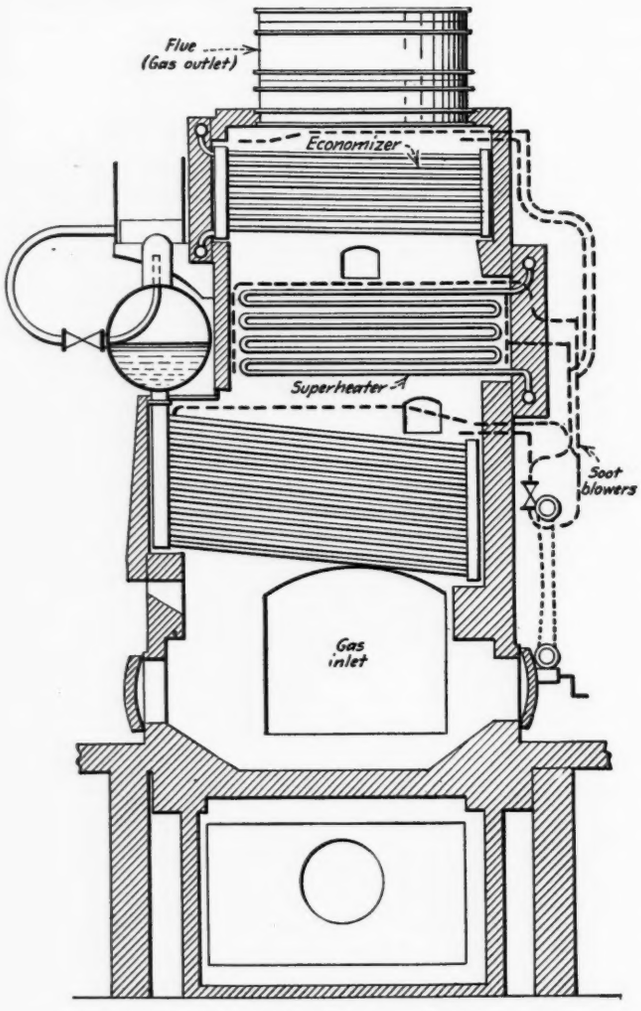
The complete process includes the following operations: magnetic separation of metallic scrap; screening (the fine material exacted from this operation is sold as fertilizer); pre-incineration drying; generation of electric power; fabrication of construction materials.

Every lot of refuse collected is not submitted to the complete sequence of operations; seasonal variations in the composition permit of simplifying the treatment. In winter, for instance, it is profitable to extract the finer part of the refuse to sell as fertilizer. In summer, when

moisture content is highest, combustion improves by a pre-incineration drying.

Incineration takes place in Brechot or Boussange type furnaces. The former is more frequently used; more than 70 are now in operation. The main parts are a primary grate for drying and distillation, a secondary dumping grate and a combustion chamber. Refuse enters on the primary grate, which is in contact with the flames from the secondary grate. Combustible gases begin to evaporate and are carried away to the combustion chamber, where their combustion is complete. At periods of ten to fifteen minutes a certain amount of refuse in partial combustion is dropped from the primary grate onto the secondary grate. This grate is at the bottom of an overturning fire box, made of an outer cast-iron casing, supported by two trunnions and separated from the brickwork of the furnace by a cast-iron frame. Inside of the casing is the firebox, having the shape of the frustum of an inverted right pyramid. At the lower base is a perforated steel plate forming a blast grate. Air is admitted through one of the trunnions and pre-heated by contact with the walls of the firebox, which is also sufficiently cooled to prevent the adherence of clinker. A gear is fastened to the other trunnion and connected to a mechanism operated either manually or electrically. The firebox is nearly filled with clinker after 1½ to 2 hours of operation. It is then overturned and the clinker, with any other residue of combustion, is dropped into a bucket or a car under the furnace.

Firebox rotation and discharge of clinker takes place in less than 20 sec. Bearings for the firebox trunnions are supported by a carriage mounted on guides, permitting its removal for repairs. Capacity varies from 375,000 lb. to 275,000 lb. in a group of four fireboxes per 24 hr. of work. The steam evaporated with 1,000 lb. of refuse reaches 680 lb. The drying effect of the primary grate permits direct incineration of refuse with a moisture content as high as 60 per cent. However, preliminary drying, using the heat from the flue gas, which otherwise would be wasted, improves the overall efficiency of the process.



Cross-section of waste-heat boiler, showing permanent system of soot blowers. The furnace is not shown

The Boussange type of furnace comprises two groups of fireboxes located on either side of the boiler. The fireboxes are of cast iron, rectangular in shape, forming double walls and a double bottom. Perforations in the double bottom form a blast grate. Air passing inside of the double walls is forced through the perforations. The small ends of the fireboxes are crossed by a ram that pushes the clinker out of the furnace.

Air is supplied to both types of furnaces by a fan under a pressure of approximately 10 in. of water.

From the furnaces the gases of combustion pass into waste-heat Niclausse cross-drum boilers, provided with economizer, superheater and an elaborate permanent system of soot blowers. Boiler tubes, superheater and economizer, form three separate banks, one above the other. The economizer is at the upper part, just under the flue; the superheater in the center and the main bank at the lower part under the inlet of hot gases. Furnace gases are admitted to the boiler at a temperature of 2,700 deg. F. and released at 400.

The sectional headers at the front of the boiler, shown in cross-sections, are interiorly divided in two compartments. Boiler tubes are made of an inner circulating tube connected to the front header compartment, and of an outer generating tube communicating with the rear compartment, which opens into the drum. Water from the economizer is admitted into the front compartment, passes through the circulating tubes and is vaporized in the space between the outer and inner tubes. From the outer tubes, steam passes to the rear compartment of the header and then into the drum.

Buckets or cars containing clinker are carried away by a monorail conveyor and unloaded into a system of crushers and screens which gradually reduces the size of the pieces and separates them in three sizes: up to 0.6 in., adequate for brick making; 0.6 to 1.6 in., suitable for concrete mixing, and 1.6 in. up, including unburnable residues, used for filling.

The generating station at Issy-les Moulineaux is equipped with three 6,000-kw. turbine-generator units. Turbines are provided with surface condensers and air ejectors. Circulating water is taken from the Seine River. Three 7,500-kva. transformers step the voltage to 10,500.

A 750-kw., 380-volt service generator and two 1,000 kva. transformers which lower the voltage from 10,500 to 380 meet the power requirements of the plant. The latter amount to about 15 per cent of the yearly output.

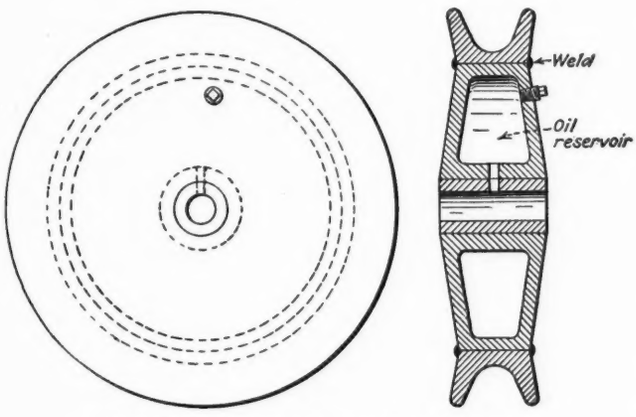
The number of furnaces in operation is regulated to obtain a continuous output of power at the time needed. Power production is constantly maintained except during a few hours at night. Smaller collection of refuse during the summer requires shorter hours of operation.

In order that all of the steam produced might be used at any time for power generation, the generators are connected to the system of a public utility company, which returns the power received to the water supply plants of the city. This solution has proved excellent, permitting the furnaces to work at their utmost efficiency, regardless of the demand for power.

...RIGHT OUT OF THE PLANT...

Practical Method of Renewing Cable Sheaves

THE company with which I am connected operates two machines with a large number of cable sheaves or blocks. The sheaves are cast steel, with a cored-out annular space around the pinhole where oil is put to lubricate the pin. To replace one of these sheaves costs about $50 and is an expensive item in the upkeep of the machines.



New rim is shrunk and welded on old center

We have found that when one of the sheaves wears until the rope nearly penetrates the oil pocket it can be renewed for as little as $15 in the following manner:

Turn down the wheel on a lathe until a surface is obtained upon which a new steel ring may be shrunk, the ring being later turned to the required diameter and shape. Extra reinforcement and security may be had by welding a bead around the joint as shown in the illustration.

W. S. WHITING, JR.

Butler, Tenn.

Hot Water and Cold Air From a Refrigerating System

THE PLAN OUTLINED by D. F. Randel on page 779 of the May 19 number would deliver hot water, partly as a byproduct of refrgeration, but at a higher cost than he thinks. I visited the only refrigeration plant devoted exclusively to air cooling in this locality and did some checking up on this method. In the first place, compressing all the ammonia used from 10 lb. abs. to 180 lb. abs. requires at least 50 per cent more power than if refrigeration only is carried on at usual suction pressures.

The plant has 250 hp. in motors operating compressors, and the power rate is 1.8c. per horsepower-hour. If they added Mr. Randel's hot-water plant and additional compression to raise the suction from 10 to 55 lb. abs., at least 125 additional horsepower would be required, because if the only requirement was cooling water to 47 deg. as outlined in Mr. Randel's plan, suction pressures could easily be carried at 55 lb. abs. or higher. This additional power costs $2.25 per hour and B.t.u. recovery is as follows (assuming 100 per cent recovery of all heat entering the system): $(250 + 125) \times 2{,}546 = 954{,}750$ B.t.u., heat equivalent of purchased energy to operate the plant. The plant that this formula was applied to cools 80,000 cu.ft. of air per minute from 90 deg. to 75 deg., and the heat release is then $80{,}000 \times 0.0722 \times 0.2375 \times 60 \times 15 = 1{,}235{,}139$ B.t.u., giving 2,189,889 B.t.u. for an expenditure of $2.25, or 9,732 B.t.u. for one cent for purposes of comparison wth a fuel-burning hot-water heater.

Buying coal at $7 per ton, heating value 14,000 B.t.u. per pound and with heater only 50 per cent efficient will give 20,000 B.t.u. for each cent expended. Therefore Mr. Randel's combination of absorption and compression refrigeration and heating plant cannot furnish hot water nearly as cheaply as a fuel-burning heater.

Springfield, Mass. A. F. SHEEHAN.

Long Exhaust Line on Two-Cycle Engine Causes Trouble

WHILE LONG EXHAUST LINES may be permissible if the oil engines are of the four-stroke-cycle type, they will cause trouble with two-stroke-cycle engines.

The reason is that the piston of the four-stroke-cycle engine will push the gases out through the pipe at a slight expenditure of power. On the other hand, the two-stroke-cycle engine has only the kinetic energy of the exhaust gases to cause evacuation of the cylinder, assisted by the scavenging air. If the exhaust pipe is too long, the back pressure will prevent complete scavenging of the cylinder, which then cannot burn as much oil as was expected, since there is not enough air for combustion. In addition, the retention of some of the hot exhaust gases raises the cylinder temperature excessively.

In our diesel station considerable trouble was experienced with pistons cracking across the crown on the exhaust port side. The pistons of this engine are oil-cooled and the builder suggested that the cooling chamber

of the pistons might be coated with carbon due to a dirty oil cooler not cleaning and cooling the oil before it was returned to the engine. We cleaned the cooler and checked the temperature of the oil but found that it was well within the range set by the builder. The chambers in the pistons were cleaned, but we still had the same trouble.

After a year of this the electrical demand became large enough to load this unit to its full capacity of 240 kw., which it could not pull. As soon as the load was raised to 220 kw. the engine would start smoking at the exhaust and would go down and out if the load were not relieved. The erecting engineer was sent out to check the engine and found everything in good shape mechanically.

A water rheostat was built and the engine was tested, but at 220 kw. the engine quit. During the test the pressure in the exhaust line was taken with a manometer and was found to be 4½ in. of water. The gage was attached to the scavenging air line, which also registered 4½ in. of water.

The exhaust line ran along the basement ceiling to the rear of the plant, where the silencer equipped with a 30-ft. stack was located. The total length of the line was 115 ft. with three 90-deg. elbows and two 45-deg. ells.

It was recommended that the exhaust line be changed and shortened by putting it through the roof.

The line as changed measures 30 ft. to the top of the stack. A test was run after the change and the unit carried 240 kw. for four hours without any trouble. The load was run up to 250 kw., with just a trace of smoke showing at the exhaust. The exhaust temperatures are slightly above those obtained when the engine was on the test floor at the factory, which may be due to a different grade of fuel oil. This is an increase in power of 13 per cent besides the saving of fuel and lubricating oil, as we do not have to run another unit in parallel and only partly loaded. To date, we have not been troubled with cracked pistons.

Walthill, Neb. WM. W. DINGWALL.

A Challenge to Engineers

I READ with some regret the editorial entitled "A Challenge to Engineers" in the March 24 number. The real reason that engineers have been quoted as not being business men is because engineers in executive positions forget that their fellow engineers were responsible for their positions and in return betray the confidence of fellow engineers for personal ambition. They "play politics" instead of protecting the interests of the engineering profession.

Engineers who have attained high positions by virtue of valuable assistance from their fellow engineers and then fail to uphold the engineering profession deserve, in my opinion, the "shellacking" accorded them by bankers and other business men.

Other professional men, such as doctors, lawyers and architects, uphold their fellow associates and undergraduates. They believe in fair play, and have a code of ethics which builds up their profession and does not tear down what has taken years to build. Engineers, on the other hand, in supervising positions are always ready to condemn the engineer to the layman who does not understand the engineering language.

It is universally conceded that the engineer is the foundation rock of present civilization. Without him, what have become the necessaries of life would not exist. It is most unfortunate that engineers in supervisory capacities allow the management to dictate on matters foreign to their own language; because the management often fails to appreciate and understand the training and qualifications we engineers deem essential to the profession so that those less qualified may not compete and thus tend to lower the schedule of compensation.

There seems to be a lack of appreciation of the engineer and his profession by the layman, many of whom are of the opinion that engineers are being overpaid for their work. This is largely attributed to the actions of engineers in supervisory positions, who are trying to burn the candle at both ends.

There is also a serious lack of appreciation of the engineer and his profession by bankers and other professional men. It is therefore up to the engineering profession to uphold the engineer, because his case is not any different from that of the banker, lawyer or doctor. The engineer, preoccupied with development and application of his science in service to humanity, has played an unostentatious part on the stage of world's work. It is unfortunate that the true nature and scope of this work has been so little understood. There are many who still do not understand the character of service which his profession equips him to render.

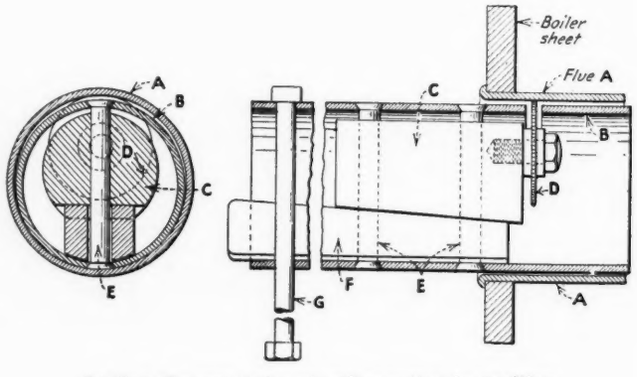
Newark, N. J. P. DIAS, *Plant Engineer*, Essex County Hall of Records

Improvised Tube Cutter for Return-Tubular Boilers

IN SMALL PLANTS it frequently happens that when a tube or flue for return-tubular boilers needs replacing no tube cutter is available. Although the tube can be cut out with a chisel, there is danger of damaging the tube sheet; therefore a suitable tool for cutting the old tube off inside the sheet should be used where possible.

Such a tool may be assembled from stock material as follows: Select a piece of ordinary pipe a size smaller than the tube to be cut, one that will just fit inside the tube. This piece should be long enough to reach out through the firebox, so that a handle through the outer end may be used to turn the pipe.

A stub piece of shafting *C* somewhat smaller than the bore of the pipe is drilled and tapped at one end to re-



Section through tube, showing cutter in position

ceive a stud bolt carrying a knurled pipe cutter wheel. Two $\frac{3}{8}$-in. holes are then drilled through the pipe B and through the stub shaft C for two rivets as shown. The bottom side of the stub shaft should be tapered and a wedge fitted below it, the function of the wedge being to feed the cutter into the tube.

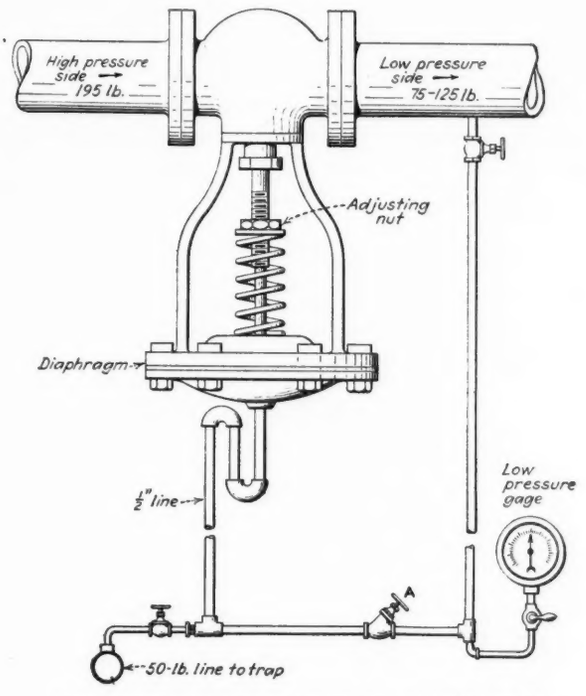
In operation, the tool is inserted in the tube until the cutter is just inside of the boiler sheet. The wedge F is then tapped in, forcing the cutter against the inside of the tube. The pipe B is turned by means of the handle G and the process continued until the tube is cut through.

North Bend, Neb. G. G. McVICKER.

Control for Pressure-Reducing Valve

IN ORDER TO SIMPLIFY the arrangement of the piping pressure-reducing valves on steam lines are often located where they are inaccessible to the operator. On a line where changes in pressure are frequently desired, necessitating readjustment of the spring tension, the following arrangement may prove helpful.

As shown on the diagram, the small line from the diaphragm chamber to the low-pressure side of the valve is



Arrangement of manual control for reducing valve

brought down to the operating floor level and a globe or angle valve inserted in it. A pressure gage is connected from the low-pressure side ahead of the controlling valve as shown. The spring of the valve is adjusted for the lowest pressure ordinarily required.

Just below the diaphragm a syphon is placed in the $\frac{1}{2}$-in. line to keep cold water in direct contact with it. Below this, but before the controlling valve A, a $\frac{1}{8}$-in. line is led off to a 50-lb. line running to a trap. This $\frac{1}{8}$-in. line is connected to the trap intake through a globe valve, and by proper adjustment a continuous flow is insured in the diaphragm connection. Any change in the opening through valve A causes a corresponding change in the opening through the main valve. H. M. SPRING.

Milford, N. J.

Heavy Oil in Solid-Injection Diesels

THERE SEEMS TO BE considerable discussion upon the suitability of heavy fuel oil for diesel engines. Until recently we were burning a mixture of two grades that resulted in an oil of about 21 deg. to 22 deg. Baumé, and had fixed on this as a standard, with no desire or expectation of a change. However, certain events made it desirable to seek further economies in fuel if it could be accomplished without too much expenditure for new material.

As an experiment, the oil heating system was extended, and made more direct, to secure as free as possible the flow of the heating water used to heat the oil. The piping was covered with lagging of material on hand. The total expense of making these changes was under $10. A considerable increase was noticed in the temperature of the fuel oil at the engine pumps and it was felt that the proportion of the heavier grade of oil could safely be increased. Since then we have used mixtures of 19.3 deg. Baumé and also of 18.6 deg., which last has been adopted as standard.

These results would seem to prove that it is largely the preheating of the fuel oil that governs the grade of oil that can be used. The new mixture proportions will result in a considerable saving in fuel cost if all other conditions remain as before, and the engine exhaust indicates no change in combustion.

Aside from the apparent improvement in fuel economies an improvement in the lubrication consumption was noticed, in so far as the filtering was helped by the change. We use a gravity oil-washing system consisting of a water-jacketed tank in which the old lubricating oil is mixed with sodium carbonate and kept at as high a temperature as we can raise until the sludge is precipitated, after which the clean oil is drawn off. By making the changes we obtained a higher temperature in the water discharged from the fuel-oil heating system, which was used, in turn, to maintain the heat of the mixture in the lubricating-oil filter, incidentally improving the separation of the clean oil from the sludge, with a consequent increase of clean oil recovered from each batch.

THOS. C. HULTON.

Abras Grandes, Prov. de Camaguey, Cuba.

Repairing Steam Injector Nozzles

THE CAUSE of any unusual wearing away of the parts of a steam injector is usually dirty steam, that is, steam carrying particles of scale. These particles cut away the metal at the top end of the nozzle, leaving the hole there too large. Enlargement of the nozzle gives the injector a large capacity and that means the injector will not operate at as low steam pressure as it did when first installed.

When the nozzle has become considerably enlarged a new one should be obtained or the old one built up and reamed out. Repair is accomplished by filling the hole through the stem, as well as those around the top, with hard solder and drilling through. The whole nozzle should be cleaned well in muriatic acid; then the surfaces to be soldered should be fluxed with zinc-cut muriatic acid. When the hole has been built up it must be bored and reamed out, a tapered reamer being used to give correct shape to the nozzle. G. M. GEORGE.

Chicago, Ill.

From Among Readers' Problems

Conducted by
L. H. MORRISON

SUPERHEATING STEAM BY REDUCING—*In passing saturated steam through a reducing valve to a lower pressure, does the steam on the low-pressure side become superheated and if so, how much? What happens to all the B.t.u.s in each pound of saturated steam after it is reduced from 100 lb. abs. to 30 lb. abs.* A.H.L.

When steam passes through an orifice or reducing valve, the steam in the low-pressure side, per pound, has as much heat in it as it contained while on the high-pressure side. In other words, since no work has been done, the heat content remains constant. In the case mentioned the steam is at 100 lb. abs. pressure, dry saturated, and has a total heat content of 1,186.3 B.t.u. After expanding to 30 lb. pressure, each pound has this same number of heat units in it.

Now, dry saturated steam at 30 lb. abs. pressure contains only 1,163.9 B.t.u., consequently the difference, or 22.4 B.t.u., will superheat the steam. Allowing two degrees per B.t.u., the 22.4 B.t.u. will superheat the steam about 45 deg. The total steam temperature is going to be in the neighborhood of 250 + 45 = 295 deg. F. A more precise result is obtained by looking in the superheated-steam tables for a steam temperature that will give 1,186.3 B.t.u. at 30 lb. abs. This is found to be 296.2 deg. This temperature is less than the original temperature of the steam, which is 327.8 deg. F.

WATER REQUIRED FOR AMMONIA CONDENSER—*We have replaced an atmospheric ammonia condenser by a double-pipe condenser. Can the amount of cooling water be reduced. I understand the heat transfer per square foot is higher in the double pipe.* A.P.L.

Improved heat transfer permits reducing the heating surface, but the flow of cooling water cannot be reduced without altering final temperatures.

For example, assume that a condenser having 60 ft. of 2 in. pipe per ton of refrigeration requires 2 gal. of water per minute per ton of refrigeration with a final rise in temperature of 10 deg. F. Suppose that this condenser were replaced with one of the later types having only 30 ft. of 2 in. pipe per ton of refrigeration to do the same work. The same 2 gal. per minute per ton would be required on the condenser having 30 as on the one having 60 ft. if the final temperature of 10 deg. is assumed in each case.

CHANGING TRANSFORMER BANK TO DELTA-DELTA CONNECTION—*With a bank of transformers connected delta-delta, as in Fig. 1, could either transformer be disconnected on the high- and low-voltage sides, without changing any other connection, and have the remaining two operate open-delta, furnishing the same phase rotation for the motors on the low side? If this can be done then the two transformers' full-load rating will be 58 per cent of the delta-delta bank's capacity.* M.P.

One of the transformers may be removed from the delta-connected bank and continue operation with the two transformers. Fig. 2 is the same as Fig. 1, except that the *B* transformer is cut out of service without interfering with any of the other connections. In an emergency it may be possible to carry more than 58 per cent of the normal load of the bank on the two transformers by blowing air on the tanks, or by spraying water on them.

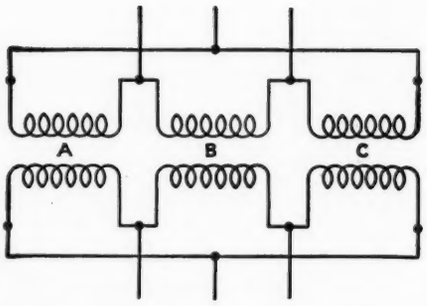


Fig. 1—Three transformers connected delta-delta

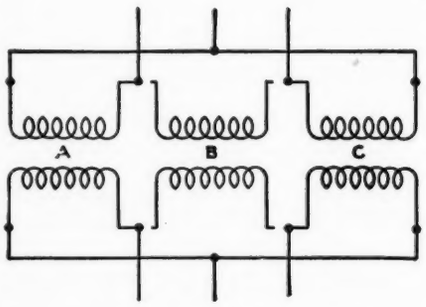


Fig. 2—Same as Fig. 1, except *B* transformer has been disconnected, leaving *A* and *C* transformers connected open delta

PREVIOUS QUESTION DISCUSSED BY READERS

THE QUESTION

A BOILER with a powdered-coal furnace operating at a maximum hourly evaporation of 12 lb. of water per square foot of heating surface has four safety valves on the boiler proper, set to operate at 600, 612, 615 and 618 lb. There is also one safety valve on the superheater. At what boiler pressure should the superheater safety valve be set to operate? Why? J.P.M.

IT IS USUAL practice to set the superheater safety valve at from two to five pounds lower than the lowest popping pressure of the valves on the main drum. With even the most up-to-date superheaters of high-temperature-resisting alloy steel their behavior at steam temperatures in excess of 1,000 deg. F. is doubtful, and superheaters of the older types should not operate at anywhere near that temperature. If the steam flow is suddenly interrupted as a result of turbines tripping or other loss of load, it is readily seen that with the high furnace temperature surrounding the superheater it is important to restore circulation of steam quickly, which shows the necessity of this safety valve setting. On the boiler mentioned the superheater safety valve should be set at 596 lb. to 598 lb., the lower value being chosen if the pressure does not build up so rapidly on loss of load due to larger steam capacity.

H. M. SPRING.
Milford, N. J.

INASMUCH as the pressure drop through the superheater was not stated, no exact answer can be given. Assuming that with an evaporation of 12 lb. of water per square foot of heating surface there will be a 25 lb. pressure drop through the superheater, the safety valve on the

superheater outlet should be set at 576 lb. Hence at maximum hourly evaporation the drum valve would pop just ahead of the superheater valve. At any lower rating, however, the superheater valve would blow first, because the pressure drop through the superheater would be reduced with lessened steam output.

In general, superheater safety valves should be set to blow at a lower pressure than the boiler drum safety valves, in order that a flow of steam may be maintained through the superheater if for any reason the main steam flow is stopped. This will avoid damage due to burning superheater tubes.

At the Northern Indiana Public Service Company's plant, which operates at 650 lb., an electrical power control valve is placed on the main steam header. This valve supplements the usual boiler safety valves which must be retained to fulfill the safety valve requirements of the A.S.M.E. Boiler Code. The power control valve is set to open at a lower pressure than the spring-loaded safety valve, and it has a blowdown of only 1 per cent; whereas the blowdown of a spring-loaded safety valve may be up to 4 per cent.

Advantages resulting from the use of the electrical power control valve are: A more even rate of steaming with more uniform pressure; a saving of steam, because of decreased blowdown; minimum use and lessened maintenance of regular safety valves. This control valve blows ahead of the boiler drum valves, and is independent of variable pressure drops through the superheater, therefore providing safety against overheating superheater tubes.

Chicago, Ill. F. E. WERTHEIM.

NEITHER the rate of furnace heat liberation nor its absorption by the boiler bears any relation to the superheater safety valve pop pressure, except in so far as the rate of boiler operation is related to superheater pressure drop.

Safety valves are put on boilers to protect them, preventing rupture due to excess pressure occuring whenever the rate of taking steam from the boiler is less than the rate of boiler heat absorption.

Since the superheater has a definite pressure loss corresponding to the amount of steam passing through it for a corresponding boiler rating, and, further, since the superheater must be protected both as to pressure and temperature, it follows that the superheater safety valve should pop first, or before the drum safety valves. This insures a continual flow of steam through the superheater to prevent excessive temperatures, which, if high enough, would destroy the superheater.

If the superheater had the following characteristics:

Boiler rate of firing, %	100	200	300	400
Super heat pressure loss, lb.	1	4	9	16

and it was predetermined that 400 per cent would be the maximum rate of boiler operation designed for 600 lb. drum pressure, then the drum safety valves should begin to pop at slightly above 600 lb., and the superheater safety valve should be set to pop at 600 minus the maximum superheater pressure drop (16 lb.), or 584 pounds.

It would then be possible to operate the boiler so as to have a superheater outlet pressure of 584 lb., theoretically, at 400 per cent of rating. Although the permissible drum pressure minus the superheater pressure loss at corresponding ratings is 591 lb. at 300 per cent rating, 596 lb. at 200 per cent and 599 lb. at 100 per cent, the boiler must always be fired to give a superheater outlet pressure just below 584 lb. If the boiler could be operated to maintain exactly 584 lb. superheater outlet pressure at all loads, then the drum pressures would be 600, 593, 588 and 585 lb. when the boiler is operated at 400, 300, 200 and 100 per cent of rating, respectively. Due to the inability of manual or automatic control to maintain exactly any given pressure, the boiler should be operated to have a superheater outlet pressure of 580 lb. at all loads, thereby preventing the safety valves from popping.

If later it was found desirable and it was possible to operate the boiler at 500 per cent rating, in which case the superheater pressure loss would probably be 25 lb., then the superheater safety valve should be set to pop at 600 minus 25, or 575 lb., and the boiler operated to give a superheater outlet pressure of 570 lb. at all loads as a practical setting. HUGH J. BYRNE.

San Francisco, Calif.

I THINK THAT the superheater safety valve should be set to operate first, that is, to operate before the safety valves on the boiler drum, at say a pressure of 595 lb., for the following reasons:

If the supply of steam from the boiler was suddenly shut off, the steam flow through the superheater would cease, and it is very likely that it would become overheated, possibly ruining some of the tubes. By setting the superheater safety valve so that it will blow before those on the boiler, sufficient steam will flow through the superheater to prevent its overheating. But if the superheater safety valve was set to blow last, and the boiler was subjected to the above conditions, there would be no flow of steam in the superheater and the chances are it would suffer considerably and perhaps be ruined altogether.

F. E. BESCABY.

Vancouver, B. C.

THE SAFETY VALVE on a superheater should be set to blow before the main valves on the boiler, say 5 lb. lower than the valve set at 600 lb, to assure a flow of steam through the elements at all times. The setting of the superheater safety valve may be such that when the boiler is steaming under load the main boiler valves open before the superheater valve. However, if the load is dropped the superheater valve will blow first. The reason for this is that as the load on the boiler increases the pressure drop through the superheater also increases. If the superheater outlet pressure is held constant, the pressure in the boiler drum will increase, and it is possible for the main boiler valves to operate before the superheater valve. P. JONES.

Montreal, Que.

THE SAFETY VALVE on the superheater should be set to operate at a pressure slightly below that at which the safety valve on the boiler proper will operate, say, in this case, 595 or 598 lb., assuming that operation is at a pressure of 585 or 590 lb. gage. Then in the event of a shutdown of the engines the safety valve on the superheater will operate first, giving a flow of steam through the superheater and protecting the superheater from blistering and overheating if the steam flow through it is interrupted for any length of time. Overheating may result if there is no hand-operated valve on the superheater. The valve would probably be an advantage when raising steam, because air and steam could be blown from the boiler through the superheater, giving the superheater some protection until the boiler is cut in on the line. O. MAYES.

Elmira, N. Y.

A Question for Our Readers

WE ARE EXTENDING our 150-lb. steam line to supply a new turbine. The new pipe is 4 in. in diameter and will be insulated with 1½ in. 85 per cent magnesia. From the main it extends 120 ft. and rises vertically fifteen feet to the turbine. What should be the capacity of the trap installed to drip this line at the heel of the vertical rise? The horizontal run is pitched away from the steam main. R.W.B.

Suitable answers from readers will be paid for[1] and published in the Aug. 18 number

[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.):

Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fritz' *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Annett's *Electric Elevators.*

Smoke Inspectors To Attack Fly-Ash Problem

Feeling that great progress has been made in smoke elimination, the smoke commissioners are planning to attack the more serious problem of curbing the emission of solids and sulphurous gases from chimneys. Setting heights for heating boilers and many other phases of smoke elimination were considered at Grand Rapids

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SMOKE PREVENTION from various angles, covering the industrial, railway and domestic heating fields, was discussed at the 25th annual convention of the Smoke Prevention Association of the United States held at the Pantlind Hotel, Grand Rapids, Mich., from June 30 to July 3, inclusive. Proper combustion methods, heating with gas and coke to eliminate smoke, district heating for the same purpose, fly-ash collection, measuring smoke and soot densities, legislation, law and ordinance enforcement, and smoke as a menace to health were some of the subjects on the program. An entire day was devoted to railroad interests, such as locomotive improvements, smoke abatement with stokers, burning low-volatile coal, direct steaming and other topics.

Solids and Gases Present Greatest Problem

All the way through the convention in papers and discussion there was a recurring undertone to the effect that great progress has been made in smoke reduction. The next step is to attack the problem of air pollution by the solids, such as cinders, soot and fly ash, emitting from chimneys, and the injurious sulphurous gases. It is the solids and gases that do the harm. Removing these will also solve the smoke problem; as one speaker expressed it, the coloring matter has been taken out of smoke. The tar content of the solids picked up has decreased; but cinder, dust and soot precipitation has increased, owing partly to the installation of many small underfeed stokers for domestic heating and the increasing use of pulverized coal. Until an efficient inexpensive way is found to eliminate these solids, little progress can be made in purifying the air.

Another forward movement was the presentation for consideration of the association of a table recommending setting heights for heating boilers equipped with mechanical stokers. As a guide for architects and consulting engineers in determining proper headroom for heating plants, this table had been prepared by the engineering committee of the Midwest Stoker Association, and was presented by the committee chairman, E. L. Beckwith. Based on results obtained with Midwest coals having 35 to 45 per cent volatile and a heat release not to exceed 50,000 B.t.u. per cubic foot of furnace volume per hour, the table covered firebox compact-welded, and horizontal return-tubular boilers. As the setting heights listed had proved satisfactory for Midwestern coals with their high volatile content, Mr. Beckwith could see no good reason for setting furnaces higher, particularly for Eastern coals, which run lower in volatile, and, generally speaking, are better coals to work with.

Action on this table of setting heights was taken under advisement by the Public Service Committee of the Smoke Prevention Association augmented by Messrs. Beckwith and Walters of the Midwest Stoker Association and a number of smoke commissioners and representatives of boiler manufacturers. Divergence of opinion prevented an immediate decision, so the matter was left to the study of the various city departments having membership in the association.

By this same body was considered the question of making some provision in the smoke ordinance for the elimination or reduction of the dust nuisance and methods of establishing violations were discussed. The final action was to appoint a sub-committee to study this phase of air pollution, to define a fly-ash nuisance, and bring back definite recommendations to the next convention.

At the opening session President James J. Fitzgerald of Springfield, Mass., reviewed the 25 years' history of the organization. Senator Conlon, of Michigan, spoke on legislation for smoke prevention. O. W. Kastens, of the Consumers Power Company, reviewed the past and present status of district heating, summarized district heating statistics, discussed types of system, described some of the leading plants and discussed the economic phases of this service. Industries, he said, are becoming conscious of the value of receiving heat from a central plant, and prospects are good for progress in this direction. A new development will be central supply of heat to the dwellings in a new real estate project.

G. D. Holliday, of the Grand Rapids Gas Company, gave some interesting facts on coke and its use as a domestic fuel to abate smoke. R. J. Bender, of the Whiting Corporation, pictured some of Chicago's pulverized-coal plants, and in conclusion made the request that the convention, before adjournment, define what constitutes a fly-ash nuisance. For boilers up to 5,000 sq.ft. of surface, he did not consider as a nuisance 25 to 30 per cent of the ash in the coal discharging from the stack. In the smaller plants the expense of doing any more than this would be prohibitive.

In smoke elimination J. E. Carey, chief smoke inspector of Toledo, favored education over court action. In this connection he proposed the raising of a $100,000 fund to finance an educational campaign in smoke abatement and the organization of smoke abatement leagues in every city in which the association is represented, the money to be provided by the smoke makers, as its elimination would mean an economic saving to them. He suggested changing the name of the organization to the Fuel Conservation and Smoke Abatement League of America, and the publication by the association of a magazine that would be a textbook on these subjects.

To prevent air pollution, V. W. Cherven of the Holland Furnace Company, stated that warm-air furnaces must have sufficient chimney flue draft and clean heating surface. The operator must be familiar with correct firing methods, must select the fuel that will give cleanest results, and eliminate air leaks above the fuel bed. Fully 80 per cent of all complaints are caused by an inadequate or leaky chimney. Methods of detecting leaks in chimneys were described. Use of a power suction machine to keep boilers clean was recommended. Firing methods covering anthracite, bituminous coal and coke were outlined, and six fundamentals were enumerated for the successful operation of a warm-air heating plant.

Oliver J. Grimes, managing director of the Committee of Ten of the coal and heating industries, outlined the purposes and activities of that body, whose headquarters is in Chicago. To advance the interests of Midwest coals, the committee acts as a clearing house for the member associations, and aids in adjusting many problems to the satisfaction of the consumer. Mr. Grimes suggested similar organizations in other communities to aid the public in its heating difficulties, which for the most

part are smoke problems caused by faulty combustion.

Discussing fly-ash collection in Detroit, J. C. McCabe selected four typical plants in that city and disclosed the percentages of combustible and ash. In a forced-draft chain-grate plant equipped with an impingement collector, the material caught was one-half carbon and one-half ash. In a powdered-coal plant equipped with an electrical precipitator the carbon was reduced to 5 to 10 per cent, leaving 90 per cent fine ash. The method is highly efficient, but the cost for moderate-sized plants is excessive. In a plant burning powdered coal and wood refuse the material caught by an internal vortex type of collector was 53 per cent combustible and 47 per cent ash. In a stack refuse collector equipped with a spray tower on a brass smelter cupola he was not able to get a distinction between combustible and ash, owing to the presence of metallic oxides.

These various types of collectors are functioning, but not doing good enough work. A comparatively inexpensive good collector of diversified type to fit different installations is needed. Sample dust collections containing 55 per cent carbon and 45 per cent ash leads Mr. McCabe to believe that the automobile is a factor in the production of carbon in the atmosphere.

A comprehensive and most interesting paper on the measurement of smoke densities and soot fall was read by W. A. Carter, of the Detroit Edison Company. Measurement of suspended impurities was divided into two classes, one in which the measurements are made out of doors and the other in which they are made within doors, such as in a boiler breeching. The various methods and equipment, such as the different smoke charts, the Umbrascope, the Bausch & Lomb smoke-inspection instrument, the Owens jet dust counter, and the automatic filter, and the measurement of ultra-violet radiation, were pictured and described.

Within-door tests included the use of the blower, the stack mirror, smoke indicator, and various types of smoke recorders. For measuring fallen impurities, Mr. Carter regards the deposit gage as the most reliable device. Numerous tables were included to indicate how the results from various locations can be recorded and compared.

In closing, the author urged the smoke inspectors to take every opportunity to advise the architects designing industrial power plants, the contractors erecting them and the operators of these plants upon means of reducing the amount of smoke and flue dust emitted from their stacks. If men of broad boiler operating experience and suitable personalities are used to make these contacts it should be possible to get better cooperation than by taking offenders into court.

It is his hope that the newly formed committee on Pure Air sponsored by the American Society of Mechanical Engineers will be able to help in the study and solution of problems pertaining to the minimizing of smoke and flue dust from stacks.

In discussing the two papers last mentioned, H. W. Evans, secretary of the board of engineers advisory to the smoke abatement commission of Chicago, advised the inspectors to forget about the problem of smoke abatement, as they were merely changing the color of the smoke cloud, and demand the elimination of the solids and sulphur gases emitted from the stacks. The latter nuisances are doing the damage to property and linen, and by getting rid of them the smoke problem will also be solved. Provisions in a smoke ordinance calling for the removal of 75 per cent of the solid and gaseous emissions from a stack would solve the entire problem, he thought.

All this was introductory to a moving-picture demonstration of the operation of a new washer by Charles M. Gerhold. Claims for the machine were that it will effectively remove the sulphurous gases and the solids emitted from a stack.

Officers elected for the coming year were as follows: James J. Fitzgerald, president; L. G. Plant, first vice-president; Herbert H. Dunn, second vice-president; Frank A. Chambers, secretary-treasurer; George Beck, sergeant at arms.

Toronto, Ont., was selected as the next convention city.

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Large Turbine-Compressor Set For Rosherville, South Africa*

TO MEET the increasing needs of the compressed-air system that supplies various mines on the Rand, South Africa, the Victoria Falls and Transvaal Power Company, Ltd., recently placed in operation what is the largest turbine-compressor in the world. This Brown Boveri unit, with capacity to deliver 77,600 cu.ft. per minute at a pressure of 135 lb per square inch absolute furnishes compressed air for pneumatic drills, operating hoists, pumps, drill-sharpening machine, power hammers, and ventilation of out-of-the-way places. The unit is installed at the Rosherville compressor station, which had an initial installed capacity in 1911 of 18,000 kw., made up of six 3,000-kw. turbine-type compressor sets driven by steam turbine.

The demand for compressed air varies widely, according to the hour of the day, and amounts to about 335,000 cu.ft. per minute during several hours of the drilling shift. For the remainder of the 24 hr., and at week-ends, the load is relatively light, but notwthstanding this the weight of compressed air supplied at present is about 6,000 tons per week day.

Some idea of the size of the system may be obtained from the fact that the

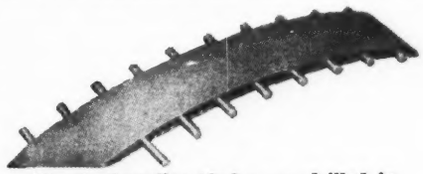

Fig. 1—Impeller blades are drilled in the side to lighten them and so reduce centrifugal stresses

total weight of air contained in the pipe system, at normal pressures and temperatures, is calculated to be about 70 tons.

The compressor set is designed to meet the following operating conditions:

Compressor	
Volume of air to be delivered, c.f.m.	77,600
Inlet pressure, lb. per sq.in. abs.	12.1
Temperature at suction, deg. F.	68
Delivery pressure, lb. per sq.in. abs.	135
Speed, r.p.m.	2,700

Because of the relatively high compression ratio of 11.16, two cylinders were necessary to accommodate the impellers. Each cylinder was subdivided into four parts, in order to permit shipment. The rotor for the low-pressure cylinder has six impellers of relatively large dimensions, whereas the high-pressure rotor has eight impellers of smaller dimensions. Each rotor is carried on two bearings, lubricated by oil under pressure from the turbine. A collar thrust bearing is provided for each cylinder, and a claw-type coupling

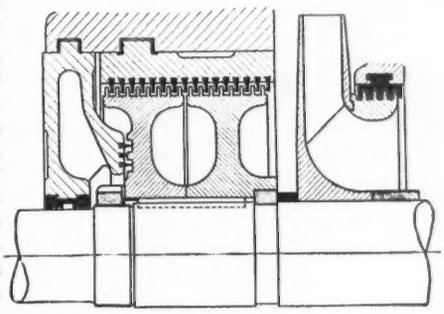

Fig. 2—Detail of balance piston for compensating axial thrust

connects the two parts of the rotor. This arrangement allows inspection of the rotor to be accomplished with a minimum of trouble. Despite the large volume of air to be handled, the rotor is of the single-flow type, which insures a simple layout for the compressor suction mains.

The low-pressure impellers are 55 in. in diameter. They are constructed of a special high-tensile alloy steel, and drilled to reduce their weight and the centrifugal stresses.

Each compressor cylinder is provided with a balance piston for compensating the axial thrust produced by the difference in pressure of the air flowing through the impellers. This arrangement was adopted in preference to a

*Abstract from Brown Boveri Review, April, 1931.

common balance piston for both cylinders, to avoid the necessity of transmitting the axial thrust through the coupling. The design of the balance piston, which is of the self-equalizing type, can be seen in Fig. 2. Any variation in the axial thrust produces a small displacement of the shaft, together with the balance piston, with the result that the play in the labyrinth glands of the piston is altered in such a manner as to cause the pressure acting on the outer face to be modified as required for compensating the thrust.

Cooling the compressor is effected by means of four pairs of tubular intercoolers, no form of jacket, or internal cylinder cooling being used. The cooler casings are arranged vertically at both sides of the compressor, and form an integral part of both the upper and lower cylinder castings. The tubes are soldered into the tube and stiffening plates, and cambered to allow for expansion. With this arrangement the space required at the side of the compressor for dismantling the cooler is reduced to a minimum.

The compressor unit is driven by a single-cylinder turbine operating condensing with steam at 170 lb. per square inch and 608 deg. F.

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Tests on Lubricants For Turbine and Engine Service*

By FRANK L. GRAY
Lubricating Engineer
Gary Works, Illinois Steel Co.

IN petroleum products the presence of organic constituents having acid characteristics, and contamination by alkalies and mineral acids, is denoted by the neutralization number, which is the weight in milligrams of potassium hydroxide required to neutralize one gram of oil. The neutralization number may be converted to per cent acidity by the equation:

$$\frac{56 \times 1{,}000}{N} = \frac{282 \times 100}{A}$$

Where N = Neutralization number
and A = Per cent acidity.
56 = Atomic weight of potassium hydroxide (KOH).
282 = Atomic weight of acid calculated as oleic ($C_{17}H_{33}COOH$).
1,000 = Conversion factor from gram to milligrams.
100 = Conversion factor to per cent.

Hence $A = \frac{28{,}200\,N}{56{,}000} = 0.5\,N$ approximately.

Therefore, the per cent acidity is practically one-half the neutralization number. This analysis is of particular value in turbine and other oils used in a circulating system.

Demulsibility Test

Rapid separation of water is a necessary characteristic, especially in turbine oils. A volume of 27 c.c. of oil and 53 c.c. of distilled water is emulsified at 130 deg. F. by rotating a paddle for five minutes at a 1,500 r.p.m. The rate of settling out of the oil in cubic centimeters per hour is called the Herschel demulsibility. The rate of separation is decreased, or possibly prevented, by foreign materials. This is a physical condition known as an emulsion. Oils in service in circulating systems, bath lubrication, and even new oils in storage, must be tested at intervals for oxidation, moisture, sediment or other changes in its properties. Several analyses are given in Table I to show action of oil over a period of time while in service.

TABLE I—TESTS ON TURBINE OIL, 140 TO 145 VISCOSITY AT 100 DEG. F.

Hours in Service	Neutralization Number Mg. KOH Per Gr. of Oil	Per Cent Acidity	Demulsibility	Color, Standard Number
New	0.01	0.005	1,620	Water white
594	0.01	0.005	1,500	1 to 1½
2,602	0.01	0.005	600	1
5,373	0.02	0.010	1,020	1
8,337	0.04	0.020	570	1½
12,431	0.029	0.0146	780	1 to 1½
14,865	0.023	0.0116	1,200	1 to 1½

The oil referred to in Table I is operating in a 30,000-kw. turbine at 1,500 r.p.m., with bearing temperatures of 110-120 deg. F. There are 2,000 gal. of oil in the circulating system, which has a bypass continuous filter. The oil is centrifuged about every 18 mo. and 150 gal. of make-up oil is used per year.

Turbine oils deteriorate in service, due to oxidation. Asphaltic material insoluble in the oil or soluble free acids are products of oxidation. In the presence of water free acids form insoluble soaps when in contact with iron or copper. These are the properties of this class of oils in which we are most interested. When the acids form soaps they become powerful emulsifying agents, and when water is present an emulsion is formed. The stability of this emulsion depends upon the acid soaps present. It is for this reason that a close check is kept on the acidity and demulsibility of the oil in service. As the acidity gets higher the separation becomes worse, so we have set a figure of 0.75 mg. KOH per gram of oil as the point at which the oil must be changed. Asphaltic material, another cause of oxidation, will be detected by the color test and also by the precipitation number, which is the number of cubic centimeters of precipitate formed when 10 c.c of oil is mixed with 90 c.c. of petroleum naphtha and centrifuged.

Emulsion tests on new turbine oil will determine the initial quality of the oil and the care of the refiner, but will have no bearing upon the stability of the oil in service.

Twenty-seven samples of oil were taken over a period of five years from a continuous filter with auxiliary heating and settling tanks of a three-cylinder direct-connected 4,000-hp., reversing steam engine and a twin-tandem, geared, 10,000-hp., reversing steam engine. The oil is constantly subject to contamination by steel mill dust and 5 per cent compounded cylinder oil. There are 3,500 gal. in the system operating at 430 gal. per hour, and an average of 500 gal. per month is added as make-up. The oil used is a treated, neutralized and filtered light engine oil with a viscosity of 125 to 135 sec. Saybolt at 100 deg. F.

TABLE II—TESTS ON OIL USED IN STEAM ENGINES

Viscosity at 100 Deg. F.	Per Cent Moisture	Per Cent Sediment	Neutralization Number Mg. KOH per Gr. of Oil
(New oil) 132	None	None	0.06
250[1]	0.48	0.63	0.60
263	0.22[1]	0.04[1]	1.37
343	0.44	0.29	0.58[1]
380	0.96	0.96[2]	1.43
400	2.16[2]	0.43	1.79[2]
440	1.96	0.26	1.49

[1] Minimum. [2] Maximum.

A direct relation is shown in Table II between viscosity, moisture and acidity, but not so with sediment. The sediment present in the samples is a fine mill dust soluble in the oil at high temperatures, which has an indirect bearing on the viscosity of the oil and a direct relation to the sludge formed.

With the same system working on less capacity, operating at 780 gal. per hour, a sediment percentage of 0.49 was recorded after the settling tanks had been cleaned and 700 gal. of make-up oil added. Two weeks later at a rate of 720 gal. per hour the sediment had increased to 1.34 per cent. During this period an average of 1,692 gal. of make-up oil per month was added. The great amount of make-up oil was necessitated by the rapid formation of an emulsified sludge, because the oil did not have sufficient rest to settle out the suspended solids.

By periodical analysis only can oils in service be intelligently watched and unnecessary shutdowns prevented. This necessitates the cooperation of an oil chemist or one competent to use the proper equipment for an oil analysis.

*Abstract from a paper presented at the 27th annual convention of the Association of Iron and Steel Electrical Engineers, held in Cleveland, June 15 to 19.

New Furnace Forces Air Through Pulverized Coal

RADICAL CHANGES in the design of pulverized-coal furnaces were recently proposed by T. F. Hurley, a British engineer. In a paper presented before the Institute of Fuels, and reported in the April issue of the *Journal* of the Institute, Mr. Hurley developed a theory indicating that turbulance is not necessary, and that more rapid combustion can be obtained in a streamline furnace utilizing centrifugal force to hold the pulverized fuel in position while the consuming air passes through it.

Mr. Hurley agreed with previous investigators along this line that the rate of combustion is determined almost entirely by the relative movement of the coal particle in respect to the surrounding gases. He showed also that under normal conditions the particle quickly acquires the velocity of the surrounding gases, even where there is a wide difference in velocity at the start.

He pointed out that with coal on grates high rates of combustion are possible, in spite of the extremely small ratio of coal surface to coal volume, because the coal stays stationary while the gases pass by. He therefore sought some means of producing an equivalent effect with pulverized fuel, and chose centrifugal force as the logical means of accomplishing this.

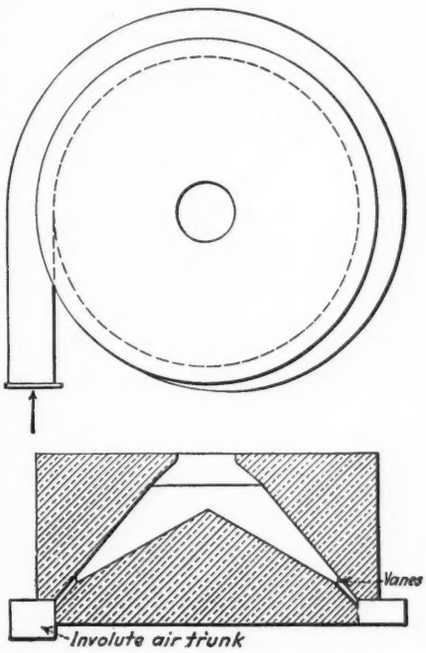
Mr. Hurley then studied some of the most successful so-called turbulent burners, and decided that their success is not due to the turbulence itself, but to centrifugal forces. He said: "Unless very violent indeed, mere turbulence is insufficient to cause a fuel particle to change from one stream to another; it cannot escape from the inert atmosphere by which it is rapidly surrounded, and it does not find its way into an atmosphere containing fresh oxygen supply. Combustion, therefore, is slow and uncertain, and can only be completed in a relatively long time, that is, in a large combustion chamber. It follows that the logical method of burning coal in a small combustion chamber is not to induce turbulence, but to submit the fuel particles to centrifugal force, causing them to travel across the current of air flowing in streamlines.

"An analysis of the fundamental principles of the most efficient group of these burners shows that the flame consists, essentially, of an outer annulus of secondary air rotating in streamlines around an inner core of primary air and fuel, from which the fuel is compelled to travel across the streamline by centrifugal force.

"In such a burner the fuel particle is acted upon by a tangential force due to the drag of the carrying air, and outward radial centrifugal force due to its rotation, and, finally, the resistance of the air to radial motion."

Mr. Hurley said that Dr. Lander, after returning from the International Conference on Bituminous Coals, at Pittsburgh, in 1928, also suspected that the success of so-called turbulent burners was not actually due to the turbulence. Dr. Lander create an artificial "typoon" with water, and found that the flow in it was not at all turbulent, but that of a free vortex. In this he found that particles of sand would settle in coaxial cylinders through which the water would flow.

The accompanying illustration shows the cross-section of an experimental furnace built by Mr. Hurley. The chamber is small, designed to burn 400 lb. of fuel per hour. It was constructed as simply as possible, using ordinary firebrick without water cooling, and the fuel was introduced with the air through a circumferential involute instead of from a separate source.



Experimental furnace has operated at heat release of 500,000 B.t.u. per cubic foot per hour

The results obtained appear to be in good agreement with those predicted from theoretical considerations. It was found possible to run at the designed capacity, making good producer gas with very little smoke, and the ash was rejected with the gas. Visual examination showed that the fuel particles did take up an equilibrium radius.

In spite of the high heat release (over 500,000 B.t.u. per cubic foot per hour), the brickwork remained in good condition after many hours' running, and the metal vanes through which the air was supplied showed no signs of overheating.

Passenger Elevators That Go to Sea

BIG STEAMSHIPS under construction in all parts of the world run to a size and luxury requiring passenger elevators, according to the Otis Elevator Company. Nine large ships now being built in American shipyards will have passenger elevators comparable to those of the best modern buildings. Passenger elevators are being installed in vessels being constructed by other countries.

The design and construction of elevators for ships is much more difficult than for shore use and they must be provided with special safeguards because of the rolling and pitching of the ship and the damp, salt atmosphere in which they operate. All apparatus must be designed to occupy a minimum of space.

Controller switches must be so constructed that they will not close when the ship rolls or pitches. This is accomplished either by using the solenoid-type switch with the armature moving vertically to make contact, or by using the clapper-type switch on which springs are mounted with sufficient tension to prevent the switch from closing of its own weight.

Traveling cables, which carry the control wires to the elevator car, if allowed to hang free from the bottom of the car will swing and the loop of the cable will catch on obstructions in the hatch, resulting in broken electrical connections. It is necessary, therefore, to provide a protective duct or sheath made of sheet metal, for the traveling cable, extending the full height of the elevator hoistway.

All oil reservoirs for motor bearings, worms, gears and other revolving parts, have to be designed to prevent spilling of oil and at the same time to insure these parts a full amount of lubricant at all times. Since the elevators operate continually in a damp, salt atmosphere, all vital parts must be protected against rust or corrosion. The car safety and the counterweight safety parts must have a rust-resisting finish, such as Parkerizing or cadmium plating, to insure that these parts shall always be in working order.

In addition to the safeguards furnished with elevators operating under normal conditions, ship elevators must be equipped with a special safety device mounted on the counterweight frame. This safety is designed to operate immediately, in case the hoisting ropes break, and prevent further descent. This insures the safety of persons who may be below the lowest landing of the elevator.

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AT THE Hartford meeting of the A.S.M.E., Council authorized the Research Committee of the society, through appointment of a sub-committee, to advise and cooperate with Dean A. A. Potter of Purdue University in the matter of research projects and experiments to be conducted on the new 3,200-lb. boiler recently installed in the university laboratory.

WHAT'S NEW IN PLANT EQUIPMENT

New Pipe Fittings for Welding

A COMPLETE line of seamless steel fittings for welding, consisting of elbows, tees, reducing tees, bull plugs and reducing nipples, as well as the Taylor forged-steel butt-welding flanges which have been on the market for over three years, has been developed by the Taylor Forge & Pipe Works, Box 485, Chicago, Ill. All sizes to 24 in., inclusive, will be ready for distribution within the near future, but at present only sizes 12 in. and smaller are available. The

Typical group of Taylor seamless steel pipe forged fittings made to facilitate pipe system fabrication by welding

tees are made in sizes of 2 to 8 in. This line of seamless pipe fittings permits entire pipe systems fabricated by welding to be installed with the use of only circumferential welds.

Taylor fittings are light in weight, requiring relatively few and light supports. The elbows are made without thinning or buckling of the walls, and have the advantage of short tangents to facilitate welding and accurate lining up. Elbows are made of the standard center-to-end measurement of American standard extra-heavy screwed fittings, and with end-to-center-to-end dimension equal to 66 times the nominal pipe diameter. The ends are machine-tool bevelled, providing a smooth, clean surface for welding.

The tees are a forged tubular product not to be confused with forged-steel tees that are made solid and drilled out. They are made to pipe thickness at the ends, with the body thickened up, especially around the outlet, to give the required reinforcement. The tees also have sweep outlets, this feature being particularly important in high-velocity lines.

Claims made for the forged fittings may be stated briefly as follows: The reducing nipples are designed especially for welding, with sufficient length to aid installation, yet shorter in dimension than that of the screwed reducing nipple. The smooth, well-balanced shape of the reducing section reduces materially the friction to flow. The bull plugs are forged under approved conditions, formed to an ellipsoidal shape to withstand end pressure, and made with a surplus of straight section to enable easy and simple attachment to the pipe. The butt-welding flanges, providing for the insertion of valves in welded pipe installations, have a long fillet at the hub to prevent distortion, and are made to comply with American standard strength requirements.

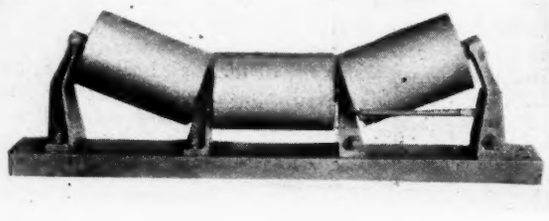
Improved Belt Conveyor Idlers

A SERIES OF CONVEYOR BELT troughing and return idlers equipped with roller bearings has been brought out by the C. O. Bartlett & Snow Company, Cleveland, Ohio. The bearings of each pulley are provided with a positive screw adjustment so arranged that wear may be taken up without removing the pulley from the supporting brackets.

Provision is made for renewing the pulley shells without destroying the pulley ends, which are made of cast iron. These renewable shells are made from seamless-steel tubing, $\frac{1}{2}$ in. thick and 6 in. in diameter.

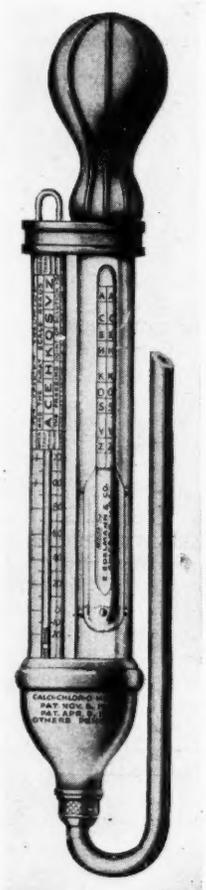
Four brackets, mounted on an inverted steel channel, support the three pulleys of the troughing idler which provide a continuous support across the belt except for a $\frac{1}{4}$-in. gap between pulleys. Open tops in the brackets permit any pulley to be removed without disturbing the bracket or adjacent pulley.

A single grease-fitting serves to lubricate the two bearings of each pulley in the troughing idlers. The longer return idler pulleys have a fitting for lubrication at each end. The Series 40 troughing and return idlers are offered in nine sizes for belt widths ranging from 18 to 60 inches.



Series 40 troughing idler with renewable pulley shells

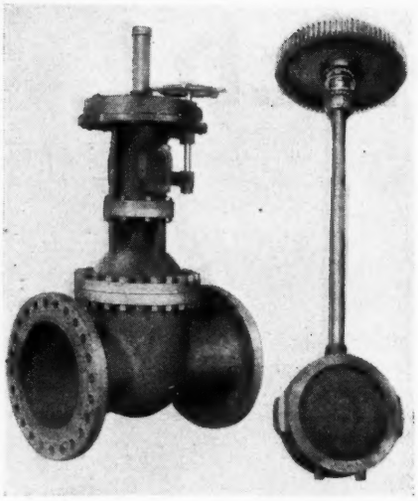
Testing Instrument for Calcium Chloride Brine



THE INSTRUMENT illustrated, called the "Calci-Chlor-O-Meter," is designed to show the exact freezing point of any calcium - chloride brine automatically, taking into consideration the temperature of the brine. The freezing point of any brine, from —20 to +120 deg., can be ascertained with accuracy in as brief a time as it takes to read the instrument.

The instrument combines in a single syringe everything necessary to make a complete test: a hydrometer and thermometer with a container and means of withdrawing the brine. It has its own correction table, which resolves the float scale reading and temperature reading down to the true freezing point.

With this instrument, which is made by E. Edelmann & Company of Chicago, Ill., it is not necessary to have a knowledge of mathematics or chemistry to make an accurate test.



Gate valve with ball bearing thrust

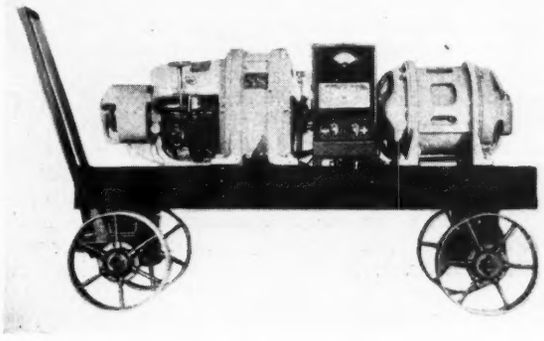
Ball Thrust Bearing Gate Valve

USE OF BALL THRUST BEARINGS characterizes a line of gate valves designed for 600 lb. gas pressure recently developed by the National Machine Works, 1559 Sheffield Ave., Chicago, Ill.

The valve body is of cast steel. The disk and the gate are of high-carbon steel and seat faces of nitro-alloy. The two ball thrust bearings are totally inclosed within the valve housing. In the valve illustrated the measurement from fact to face of flanges is 48½ in., the inside diameter 16 in. and the total lift 12 inches.

Arc Welder With Single Adjustment

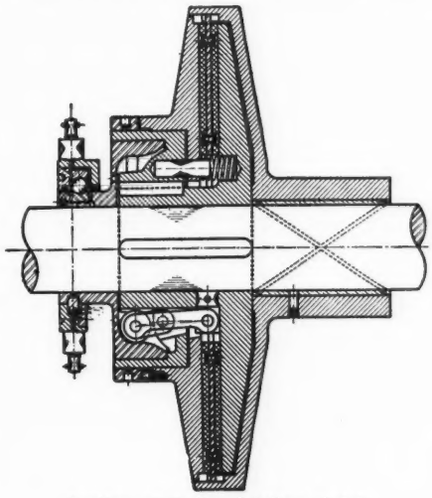
ONLY ONE ADJUSTMENT is found on the full-range arc welder announced by the USL Battery Corporation, Niagara Falls, N. Y. All current adjustments are made by a simple "electrode indicator," which is set by the operator for the size of electrode being used. The machine is then ready for the welding job. A high striking voltage of 60 is provided and is constant for all commercial sizes of electrodes, either bare or coated. The generator is designed to produce an arc which prevents burning on light work and assures deep penetration on heavy work.



Full range arc welder which has no voltmeters, switches or rheostats for voltage and current adjustments

Completely Inclosed Friction Clutch

A COMPLETELY INCLOSED disk clutch for power-transmission service is being offered by the Dodge Manufacturing Corporation, Mishawaka, Ind. In both the engaged and disengaged positions the clutch is fully inclosed, assuring safety as well as protection against dust and dirt. The clutch consists of a laterally free friction disk capable of being clamped between two heavy steel disks, one of which is keyed to the central shaft, which may be either the driving or driven member. Compression of the disk between the clutch faces is by three toggle members actuated by an internal cam of cylindrical form, which



Section of Dodge friction clutch

is moved lengthwise on the shaft by a slip ring and shifting yoke.

The friction disk consists of two ground asbestos disks riveted to a steel plate through which the torque is transmitted at its periphery.

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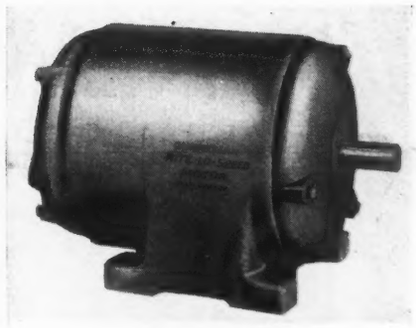
METAL SPRAYER — This device, designed for building up metallic surfaces, can be used to spray lead-tin alloys or any metal with a low melting point. It can also be used for spraying lead on tanks requiring protection from acids. The device weighs 24 lb., operates on 110-volt a.c. or d.c. current, and requires compressed air between 75 and 125 lb. per sq.in. It is put out by the Taywal Corporation Sales Agency, Chattanooga, Tenn.



Christian Rite-Lo-Speed motor

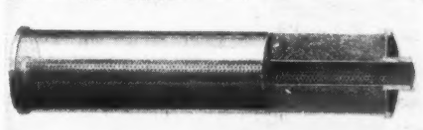
Motorized Speed Reducer

EMBODYING A STANDARD footless stator and rotor and heat-treated alloy steel helical gears, the "Rite-Lo-Speed" motor introduced by J. D. Christian, 512 Brannan St., San Francisco, Calif., is put out in four series and in sizes from 1 to 30 hp., with a junior model in sizes from ¼ to 1 hp. The gears comprising the power transmission are ball bearing mounted and arranged in a compact manner so that the entire assembly is scarcely larger than the motor itself. The entire assembly is protected by a dirt- and water-proof housing.

Series S is standard, comprised of the motor and housing with a single power take-off. Series B is a single-motor unit with a gear housing at each end having two power take-offs at the same speed. Series C is the same as Series B with the exception that it has two power take-offs at different speeds. Series D is a single motor unit with gear housing at one end with power take-off at reduced speed and with a high speed motor shaft extended through the rear end bell.

Silencer for Air-Compressors and Blowers

ABSENCE OF BAFFLES and obstructions of any kind to the flow of air or gas is a feature of the new line of silencers



Burgess straight-through silencer

for air compressor intakes announced by the Burgess Battery Company, 111 West Monroe St., Chicago, Ill.

Briefly, the silencer consists of a perforated pipe surrounded by a sound-absorbing material, the whole being inclosed in a jacket or shell. With this design a straight opening is provided through the muffler equal to the inside area of the pipe line. It therefore offers no more restriction to the flow of air than the same length of standard pipe. The sound waves expand into the absorbing material and are destroyed. Sizes range from ⅛ to 6 inches.

NEWS of the FIELD

Federal Power Commission Inaugurates Survey of Operating Company Control

FOR THE PURPOSE of obtaining facts "needed in carrying on its functions prescribed by the Federal Water Power Act," the Federal Power Commission has started an investigation of the ownership, control and affiliations of the public utility operating companies which are licensees of the commission, it was announced last week by Chairman Smith.

This study, it was stated, will "include the collection of all available facts bearing upon the ownership and control, direct or indirect (through stock ownership or control or otherwise), of stock, security, or capital interest of public utilities engaged in the developing, transmitting, or distributing of hydro-electric power for sale or use in the public service where the same enters into interstate business, or where the same, or any part thereof, shall be subject to regulation by the Federal Power Commission under the jurisdiction conferred by the Federal Water Power Act; by holding companies, investment trusts, individuals, partnerships, corporations, associations, and trusts, and the organization, financing, development, management, operation, and control of such holding companies, investment trusts, partnerships, corporations, associations, and trusts."

Dr. Walter M. W. Splawn, who last winter completed an investigation of railroad holding companies for the House Committee on Interstate Commerce, has been engaged by the power commission as special assistant to conduct its study.

Temporary Stay Granted Against Iowa Power Tax

AFTER A HEARING before three judges in the federal court at Boise, Idaho, the court issued a temporary injunction against the attorney general of Idaho and the commissioner of law enforcement to prevent them from collecting the kilowatt-hour tax against the Utah Power & Light Company enacted at the last session of the Idaho legislature.

The court indicated, in closing the hearing on July 3, that its decision in the matter will be rendered about Sept. 1. The decision will be on a motion of the state of Idaho to dismiss the action. The Utah Power & Light Company was required to post a $30,000 bond to insure the state against loss. The state secured permission, in case of a decision against the law, to re-open the case for introduction of evidence.

Both sides have indicated preparations to take the case to the United States Supreme Court. The power company assailed the law on several constitutional grounds and submitted affidavits tending to show the tax applied to a commodity which went instantly into interstate commerce and for that reason was out of the state's tax range. The state contended the power was developed from a resource within the state and was therefore taxable. Counter affidavits were submitted.

New Safety Rules Added to California Boiler Code

TO MAINTAIN reasonable safety in the operation of steam boilers, the California Industrial Accident Commission has deemed it necessary to add new sections to its Boiler Safety Orders, it was announced recently by F. A. Page, chief boiler inspector of the commission. The new regulations take care of conditions which are either not covered or insufficiently covered by present sections, particularly in connection with boilers that have been in service twenty years or more.

The first two sections of the new rules provide for the periodical removal of enough tubes to allow thorough test and inspection of fire-tube and horizontal-tubular boilers over 36 in. in diameter, where the design is such that proper examination of the internal surfaces of shell or drums is otherwise impossible. Another section covers the maximum age, minimum thickness and length of secondhand tubes used in water-tube boilers. Provision is made in other sections for the reduction of the working pressure to 50 lb. per sq. in. after Jan. 1, 1940, in 36-in. drum boilers of lap-seam construction, and the increase of the minimum factor of safety from 5 to 5.5 after Nov. 1, 1935.

Another section stipulates that the minimum factor of safety to be used in calculating the allowable working pressure on shells of horizontal-tubular boilers over 36 in. in diameter, having two longitudinal lap seams running the full length of the shell, shall be based on the age of the boiler, which factor shall be increased by one-half point beyond the factor of 5 for each five years over twenty years of age.

Other sections require that the riveted and staybolted surfaces of newly installed, internally fired boilers be left uncovered until after each boiler has been fired up and all leaks stopped, and that the seller of a boiler, changing both ownership and location, must report such sale to the commission, giving the state serial number, name and address of purchaser and the new location.

Beauharnois Inquiry Goes On; Results Inconclusive

RESULTS to date of the investigation into the affairs of the Beauharnois Power Corporation before a special committee of the Canadian House of Commons are inconclusive on every count. There has been a conflict of engineering opinion over certain navigation features of the canal, the beginning of a legal debate over the validity of the order-in-council by which the Federal Government approved the Beauharnois scheme in 1929, and revelation of the fact that Beauharnois has not yet obtained formal sanction of the detail plans for work now in progress. Rumors of a very serious nature involving high officials of the company, statesmen and even members of the judiciary are flying thick and fast, but so far there has been no evidence of this kind aired before the committee. Auditors are now at work on the company's books, and counsel for the committee has intimated that he will soon commence the examination of individuals who will be able to discuss the financial aspects of the company's activities.

The principal development of the last few days of the inquiry has been a sharp difference of opinion between two Dominion Government engineers on the merits of different phases of the navigation and power project. K. M. Cameron, chief engineer of the Department of Public Works, declared he was generally in agreement with the plans under which the Beauharnois canal was being built. In this he openly differed from D. W. McLachlan, engineer of the Department of Railways and Canals,

who is also chairman of the Canadian section of the International Joint Board of Engineers which investigated the waterway scheme. The whole regular flow of the St. Lawrence River could be turned through the Beauharnois canal without unsatisfactory effects on navigation, Mr. Cameron believes, while Mr. McLachlin declares that navigation would be difficult if not impossible if this were done.

Ambrose Swasey Makes Gift To Engineering Foundation

AMBROSE SWASEY, founder of The Engineering Foundation and surviving member of the firm of Warner & Swasey, has added $250,000 to his previous gifts to the foundation, bringing their total to $750,000. The gift was made at a dinner given recently in New York City by Chairman H. Hobart Porter of the foundation, at which Mr. Swasey was the guest of honor.

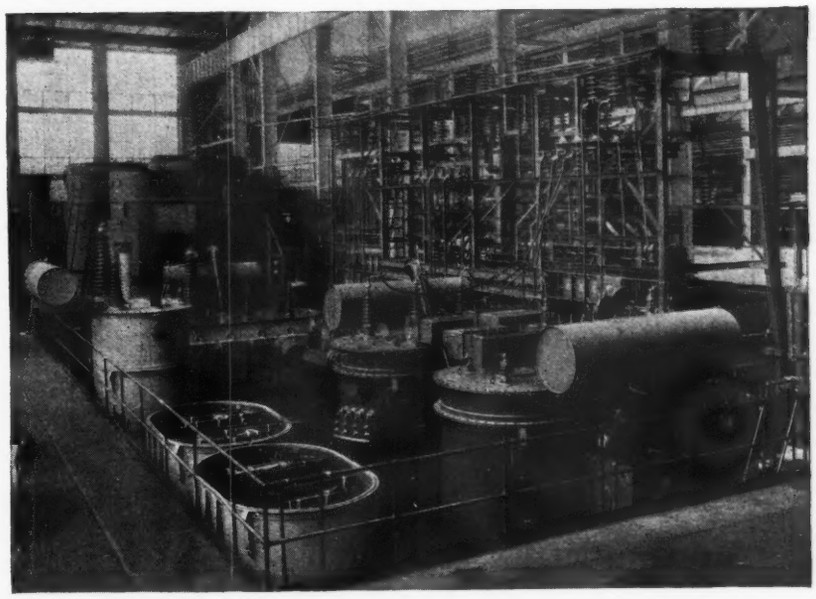
In making this gift Mr. Swasey said, "For many years past, and especially since 1914, I have thought that a great service to mankind might be rendered by the stimulation of research and development work in the engineering profession, and have sought to further that end by assisting in establishing The Engineering Foundation, whose income would be available for such purposes.

"It has been my privilege on previous occasions to assist in the endowment of this foundation, and, having a high appreciation of the very practical and helpful results that have been already achieved, and believing that the broad and well-laid plans of the foundation promise even greater service in the future, I now take great pleasure in making available to The Engineering Foundation, through United Engineering Trustees, Inc., an additional fund of $250,000 for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind."

75,000-Kw. Substation Completed at Herndon

ADDING 75,000 KW. to the power facilities of the San Joaquin Light & Power Corporation's system, its new substation at Herndon, about ten miles north of Fresno, Calif., was placed in operation June 30. From this substation a 100-mile, 220-kv. transmission line has been built to Bellota, where it ties in with the Pacific Gas and Electric system. From Bellota, the line extends to the Wilson substation, using the steel towers of the present 220-kv. Sacramento-Merced line erected by the Great Western Power Company. This interconnection makes available to the San Joaquin system electric power from both the hydro and steam-electric power from the new plants at San Francisco.

THE "ACID TEST" FOR TRANSFORMERS



The two large 20,000-kva. water-cooled transformers shown in the foreground are undergoing tests for copper losses, in the "big pit" at the Pittsfield Works of the General Electric Company. Along the left wall of the pit, three 26,000-kva. machines which have successfully undergone a series of tests are shown awaiting "finishing", prior to being disassembled for shipment. At the far end of the pit an oil-immersed, airjet-cooled 25,000-kva. transformer is set up for regular factory tests]

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A.S.A. Adopts Formula For Pipe-Wall Thickness

A BASIC FORMULA for use in calculating pipe-wall thickness suitable for various pressure-stress relationships has recently been adopted by the Sectional Committee on Standardization of Wrought-Iron and Wrought-Steel Pipe and Tubing of the American Standards Association. The formula is based on the Barlow formula with modifications to provide for mill tolerance, metal removed in threading, mechanical strength and corrosion. It is as follows:

For pipe of nominal diameter ½ in. and over.

$$P = \frac{1.75S}{D}\ (t - 0.1)$$

where P = the internal pressure in lb. per sq.in., gage;
D = the outside diameter of pipe in inches;
S = the fiber stress in the wall in lb. per sq.in.;
t = the pipe wall thickness in inches.

Among the advantages claimed for this formula in the computation of pipe-wall thickness schedules are that it eliminates the use of two formulas, permits the selection of one value of P/S for each schedule of pipe-wall thickness and involves a minimum of change in existing pipe standards.

So far tentative pipe-wall thickness schedules for 1,000 P/S ratios of 25, 40, 50, 70, 105 and 155 have been set up to indicate the application of the formula. Consideration is also being given to the values of stresses allowable in piping for temperatures above 750 deg. F., for use in connection with the basic formula.

Purchasing Agents Want Standard Valve Markings

DIFFICULTIES and sometimes serious accidents resulting from lack of uniform markings, or entire absence of markings, on valves and fittings have prompted the National Association of Purchasing Agents to establish a committee whose object will be to develop uniform markings and promote their general adoption by manufacturers. The work is under the chairmanship of E. H. Weaver, district purchasing agent, Union Oil Company of California, Seattle.

In the oil fields particularly, where valves and fittings are used several times, lack of uniform markings becomes a serious problem because of inability to identify pressures, but all other users of valves and fittings are more or less handicapped. The difficulties arise from confusion as to pressures, some valves showing safe working pressures, others test pressures; some show steam pressures while others apply to oil, water and gas. In many cases casting numbers are shown. The recent use of various alloys in valve manufacture adds another reason for confusion,

for users cannot properly identify the valves when ordering new parts or replacements.

The N.A.P.A. is inviting the cooperation of the American Petroleum Institute, National Electric Light Association, American Standards Association, American Railway Association and others whose members are directly concerned with the problem.

A survey of difficulties actually experienced is now in progress, the results of which will form the basis for a joint conference between manufacturers and users of valves and fittings, sometime this fall.

Start Investigation of Los Angeles Power Board

APPOINTMENT of a special committee of nine citizens to conduct a thorough investigation of operations of the Los Angeles department of water and power in order to put at rest rumors concerning the department and particularly concerning the power bureau has been made by John C. Porter, mayor of Los Angeles. Announcement of the appointment was made in a recent message to the City Council, and was accepted after the council had defeated a motion to refer the message to the council's water and power committee.

The investigation committee members named by Mayor Porter, are Oscar Lawler, attorney; George J. Kurtz, president Los Angeles Railway Corporation; George V. Brock, president Brock & Company; C. J. Thorson, former banker; Merritt H. Adamson, president Adohr Creamery; William A. Simpson, president Simpson Construction Company; G. D. Robertson, president Los Angeles Realty Board; E. J. Fleming, president Downtown Business Men's Association, and Victor H. Rossetti, president Farmers' & Merchants' National Bank.

Obituary

GEORGE EUGENE SLY, former vice-president of the United Publishing Company, died on July 7 in St. Charles, Mo., from a stroke of apoplexy. He was on his way to the Missouri Ozarks for a vacation. Born in Fredonia, N. Y., 60 years ago, he was at one time advertising representative of *Power* in New York City.

GEORGE FILLMORE SWAIN, professor emeritus of engineering at Harvard University and one of the leading authorities in the country on hydraulic engineering, died unexpectedly on July 7 at his summer home in Holderness, N. H. Professor Swain was born on March 2, 1857, in San Francisco, Calif. He received his technical education at the Massachusetts Institute of Technology and the Royal Polytechnique School in Berlin. A teacher of civil engineering, first at M.I.T. and later at Harvard, he was also a consulting engineer of national reputation in the hydraulic, railroad, construction and architectural fields. He was a member of the American Society of Civil Engineers and the Society for the Promotion of Engineering Education.

FRANCIS J. NANKIVELL, mechanical and electrical engineer of New York City, died on July 5 at Shokan, N. Y., of heart disease. He was 38 years old. Born in Yokohama, Japan, where his parents were living temporarily, he was graduated from Cornell University in 1918. Since that time he had been associated with several light and power companies, chiefly around New York City. He was the inventor and patentee of several labor-saving devices relating to power, and had also done considerable construction work both in this country and South America.

COMING CONVENTIONS

American Society of Mechanical Engineers. Regional meeting in Kansas City, Mo., Sept. 7-9. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Lake Tahoe, Calif., Aug. 25-28. District meeting at Kansas City, Mo., Oct. 22-24. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Welding Society. Fall meeting at the Copley-Plaza Hotel, Boston, Mass., Sept. 21-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Edison Illuminating Companies. Forty-seventh annual meeting at The Greenbrier, White Sulphur Springs, W. Va., Sept. 21-25. Secretary, Preston S. Millar, 80th St. and East End Ave., New York City.

International Railway Fuel Association. Annual convention at the Hotel Sherman, Chicago, Ill., Sept. 15-16. Secretary, C. T. Winkless, Room 700, La Salle Street Station, Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

Southwest Power Conference and Show will be held in Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, George F. Klein, Chamber of Commerce, Kansas City, Mo.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

Personals

IRVING E. MOULTROP, chief engineer of the Edison Electric Illuminating Company of Boston, recently received the honorary degree of "Mechanical Engineer" from Stevens Institute of Technology, in recognition of his work in supervising the construction of the Charles Leavitt Edgar Station, which was the first central station to use a steam pressure above 650 pounds.

FRANK O. CLEMENTS, technical director of the General Motors research laboratories, was elected president of the American Society for Testing Materials at the recent annual meeting of the society in Chicago. SAMUEL T. WAGNER, consulting engineer of the Reading Company, was elected vice-president, along with the following members of the executive committee: ARTHUR W. CARPENTER, KENNETH B. COOK, J. B. JOHNSON, GEORGE C. D. LENTH and O. L. MOORE.

O. MILNE, chief engineer of Peabody, Limited, has just returned from the Peabody Engineering Corporation's office in London, where he has been studying foreign conditions for the past year. After spending a short time in this country, he will go back to London to continue his work there.

DR. DORSEY A. LYON, director of the Engineering Experiment Station at the University of Utah, was elected president of the Utah Society of Engineers at the recent annual meeting of the society in Salt Lake City. Other officers elected are: C. C. PRATT, first vice-president; FRED RICHARDSON, second vice-president; R. R. WOOLLEY, secretary; R. K. BROWN, treasurer; and T. C. ADAMS and H. C. GOODRICH, retiring president, members of the executive committee.

J. M. HIPPLE, works manager of the East Pittsburgh plant of the Westinghouse Electric & Manufacturing Company since 1927, has been made general works manager for the company. C. H. CHAMPLAIN, manager of the Westinghouse works at Sharon, Pa., for the last eight years, succeeds Mr. Hipple at East Pittsburgh, and M. L. FAWCETT becomes works manager at Sharon.

NICHOLAS GERTEN, formerly vice-president of the Blaw-Knox International Corporation, has been elected president of that organization. Before joining the Blaw-Knox company, Mr. Gerten was an engineer in the technical department of the Mitsubishi Company.

S. ROSENZWEIG, engineering consultant and president of The Korfund Company, sailed on July 11 for an extended business trip abroad. He plans to visit many European plants and arrange for the American manufacture of such machinery isolation materials as are applicable to engineering practice in this country.

Business Notes

BEARDSLEY & PIPER COMPANY, Chicago, Ill., announces the establishment of a new department for the engineering, development and marketing of pulverized fuel systems for furnaces, boilers and heating equipment of every description. Aubrey J. Grindle, pulverized fuel engineer and pioneer in this field, has become associated with the company to head the new department. He will have complete charge of its engineering, manufacturing and sales activities.

KIELEY & MUELLER, INC., New York City, announce the appointment of the Engineering Sales Company, under the direction of H. E. Wheeler and H. J. Prebensen, with offices at 2831 South Park Way, Chicago, as their representative for northern Illinois.

FAIRFIELD ENGINEERING COMPANY, Marion, Ohio, announces that E. A. Thumlert has joined its sales organization and will specialize in the design and sales of skip hoists for handling coal and ashes, as well as ash hoppers and gates. Mr. Thumlert was formerly with the PALMER-BEE COMPANY, and previous to that was connected with the BEAUMONT COMPANY.

FUSION WELDING CORPORATION, Chicago, Ill., has appointed the Puritan Compressed Gas Corporation, 2012 Grand Ave., Kansas City, Mo., as its distributor for the State of Kansas and the western portion of Missouri.

WESTINGHOUSE ELECTRIC & MANUCOMPANY, East Pittsburgh, Pa., announces the appointment of L. S. Washington as manager of the northeastern section of the company's Southwestern sales district, and E. D. Stewart as manager of the southwestern section of the district. Mr. Washington will have charge of all activities in the St. Louis, Mo., and Memphis, Tenn., offices, while Mr. Stewart will be in charge of activities covering the Houston, Dallas, San Antonio and El Paso, Texas, offices.

THE DAMPNEY COMPANY OF AMERICA, Hyde Park, Boston, Mass., announces that William Richards has become associated with its marine department in New York. Mr. Richards was formerly chief engineer of the United States & Australasia Lines, also formerly attached to the Fuel Conservation Section of the United States Shipping Board, and recently assistant marine superintendent of the Lykes Brothers-Ripley Steamship Company, at Galveston, Texas.

SQUARE D COMPANY OF TEXAS, a subsidiary of the Square D Company, Detroit, Mich., recently opened its new factory at 3111 Polk Ave., Houston, Tex., to handle the distribution and service of Square D and Diamond Electrical Manufacturing Company products in the states of Texas, Louisiana, Mississippi, Arkansas, Oklahoma and part of Tennessee.

How's Business?

STABILIZATION of commodity prices in June is clearly encouraging, as are many indications of strength in the domestic business structure, according to *The Business Week* of July 15. "Our index for the latest week registers some slight reaction from the sharp slackening of business in June, but it is still too early, and too contrary to the usual seasonal trend, to expect any conclusive evidence of the immediate influence on the level of production and trade of the new psychological and financial factors in the picture."

Production of electricity by public utility companies for the week ended July 4 was 1,575,780,000 kw.-hr., or 2.8 per cent below the corresponding period last year, according to N.E.L.A. figures. The Atlantic seaboard shows an increase of 3.8 per cent in electrical output above last year. The central industrial region registers, as a whole, a decrease of 1.9 per cent, although the Chicago district shows an increase of 5.5 per cent. The Pacific Coast shows a gain of 0.4 per cent.

Trade Catalogs

DIESEL ENGINES—Detailed operating records of the municipal diesel plant at Madison, S. D., are given in an illustrated bulletin recently issued by the Busch-Sulzer Bros.-Diesel Engine Company, St. Louis, Mo., under the title, "7-Year Operating Record of a 15-Year Old Diesel Plant at Madison, South Dakota." A brief history and description of the plant is included with the operating data.

WELDING—Leaflet L-20518, just issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., describes and illustrates a gas-engine-driven, high-speed welder designed especially for field pipe-line welding. Another recent publication of the company is Welding Data Bulletin No. 15, which shows many unusual arc welding achievements, explains various methods of testing and discusses ways of obtaining good welds.

SWITCHBOARDS — A full description, with many illustrations, of the standardized sectional "SAFtoSWITCHBOARD" is contained in Bulletin No. 293 just issued by the Bull Dog Electric Products Company, Detroit, Mich.

METALS—The characteristics and applications of stainless and heat-resisting alloy steels are comprehensively discussed in a new publication of the subsidiary manufacturing companies of the United States Steel Corporation. Copies may be obtained from the National Tube Company, Pittsburgh, Pa.

PIPING—Bulletin 106, recently issued by Tube-Turns, Inc., Louisville, Ky., contains an up-to-date chart which facilitates the rapid and accurate calculation of expansion loops made up with "Tube-Turns" and straight runs of pipe.

PUMPS—Engineering Data Sheet No. 1, just issued by the Yoemans Brothers Company, 1433 Dayton St., Chicago, Ill., contains charts, tables and other information of use in figuring the capacities of pumps and tanks for the water supply of public buildings.

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Fuel Prices

FUEL OIL

Boston—July 8, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.83c. per gal.

New York—July 7, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 5c. per gal.

Philadelphia—June 25, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—July 8, f.o.b. local refinery, fuel oil, 30@34 deg., 2.25c.@2.75c. per gal.; 36@40 deg., 2.25c.@2.725c. per gal.

Cincinnati—July 7, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—July 2, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 27.5c. per bbl.; 22@24 deg., 35c. per bbl.; 24@26 deg., 37.5c. per bbl.; 26@28 deg., 45c. per bbl.; 28@30 deg., 50c. per bbl.

St. Louis—June 30, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.07 per bbl., or 42 gal.; 26@28 deg., $1.145 per bbl.; 28@30 deg., $1.195 per bbl.; 30@32 deg., $1.295 per bbl.; 32@36 deg., gas oil, 2.526c. per gal.; 38@40 deg., distillate, 3.026c. per gal.

Dallas—July 4, f.o.b. local refinery 24@26 deg., 70c. per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol..	New York...	$1.60 @$1.85
Pool 10, h. gr. low-vol.	New York...	1.50 @ 1.60
Pool 11, low-vol.....	New York...	1.35 @ 1.45
Smokeless, mine-run..	Chicago.....	1.50 @ 1.75
Smokeless, slack.....	Chicago.....	.50 @ 1.00
Harlan, Ky., slack....	Chicago.....	.75 @ .90
Franklin, Ill., mine-run	Chicago.....	2.15
Franklin, Ill., screen...	Chicago.....	1.25 @ 1.75
Ind. 5th Vein, m.-r....	Chicago.....	1.20 @ 1.75
Standard Ill., mine-run	St. Louis....	1.25 @ 1.40
W. Ky., mine-run	Louisville....	.85 @ 1.25
W. Ky., slack:.....	Louisville....	.60 @ .75
Pittsburgh, mine-run.	Pittsburgh....	1.30 @ 1.60
Smokeless, mine-run..	Cincinnati...	1.65 @ 1.75
Smokeless, slack.....	Cincinnati...	.75 @ 1.25
Kanawha, mine-run..	Cincinnati...	1.00 @ 1.30
Kanawha, nut-slack.	Cincinnati...	.75 @ .90

Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat.....	New York...	$3.10 @$3.25
Barley.....	New York...	.90 @ 1.40

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Fresno—N. D. and S. Naman, 3232 East Fulare St. and H. Krum, 311 Broadway, plan the construction of a pre-cooling plant on G. St.

Calif., Pasadena—City will receive bids within next two months for the construction of Pine Canyon dam, 300 ft. high above foundation on San Gabriel River, 4 mi. above Azusa; reservoir to impound 40,000 acre ft. of water. Estimated cost $5,000,000. S. B. Morris, City Hall, is engineer.

Calif., San Jose—City awarded contract for installation of ice-making and refrigeration plant in service building at County Hospital, Santa Clara County, to Carbondale Machinery Co., 1031 South Broadway, Los Angeles. $11,630.

Colo., Grand Junction — Public Service Co., c/o C. N. Stannard, Pres., 15th and Champa Sts., Denver, plans the construction of two hydro-electric plants on Gunnison and Colorado Rivers here. Estimated total cost $600,000.

Conn., Hamden—Town awarded contract for the construction of a sanitary sewer and pumping station at Spring Glen Section to A. DiMarco, 1 So. Kensico Ave., White Plains, N. Y. $93,557.

Conn., Hartford—Engineering Dept., City Hall, awarded contract for the construction of a pumping station, also flood protection in Dyke project, to C. W. Blakeslee & Sons Inc., 58 Waverly St., New Haven, $82,374.

D. C., Anacostia—Bureau of Yards & Docks, Navy Dept., Washington, awarded contract for barracks and boiler plant at Naval Air Station here to Worham Bros., Empire Bldg., Knoxville, Tenn. $251,866.

D. C., Washington—Owner c/o W. W. Jordan, 710 McLachlen Bank Bldg., plans the construction of an 11 story retail merchandise mart and theatre building including swimming pool, steam heating and air conditioning systems, elevators, etc. Estimated cost approximately $10,000,000. O. Harvey Miller, McLachlen Bank Bldg., is architect.

Ia., Creston—City, B. Tallman, Clk., will soon award contract for the construction of a sanitary sewer and sewage disposal plant improvements including pumping station, pumping equipment, sludge and water pumps, gas holders, etc. P. K. DeVoe is city engineer.

Kan., Dodge City—City awarded contract for the construction of a sanitary sewage system and pumping station, etc. to C. L. Burt, Hutchinson, Kan. $17,860.

Kan., Liberal—City awarded contract for the construction of a light and power plant including equipment to Cardin Machinery & Electrical Co., Cardin, Okla. Estimated cost $34,000.

Mass., Ayer — Constructing Quartermaster, Camp Devens, will receive bids until July 29 for the construction of an electric distribution system at Camp Devens. Private plans.

Mass., Quincy—City of Newton will receive bids until July 15 for the construction of a city hall and memorial building at Commonwealth Ave. and Walnut and Homer Sts. Estimated cost $1,000,000. Allen & Collins, 75 Newbury St., Boston, are architects. Bids for steam heating system, etc., will be taken later.

Mass., Waltham—City is having plans prepared for the construction of a high pressure water plant including pump house, etc. on Cedarwood St. Estimated cost $50,000.

Mich., Detroit—Public Lighting Commission, East Atwater St., had plans prepared for the construction of a 2 story, 50 x 50 ft. substation at Warren and 14th Aves. Estimated cost $50,000. Smith, Hinchman & Grylls, 800 Marquette Bldg., architects and engineers. Equipment will be required.

N. H., Concord—New Hampshire State Hospital is having plans prepared for a 1 story brick and concrete power plant. Estimated cost $40,000. W. A. Stone, State House, is purchasing agent. R. D. Kimball Co., 6 Beacon St., Boston, Mass., is architect.

N. J., Elizabeth—Elizabethtown Consolidated Gas Co., 16 West Jersey St., will build a 50 x 75 ft. power plant and boiler room at Third Ave. Estimated cost $40,000. Private plans. Work will be done by separate contracts.

N. J., Holmdel — Dept. of Institutions & Agencies, State Office Bldg., Trenton, postponed construction of group of institution buildings at New Jersey State Hospital. $1,350,000. Division Architecture & Construction, State Office Bldg., Trenton, Archt. and Engr. Maturity probably in September.

N. J., Little Falls—Passaic Valley Water Commission, 156 Ellison St., Paterson, awarded contract for dismantling and removal from Little Falls pumping station, two Holly pumping units, four Reidler pumping units, four Francis water turbines and penstocks, two steam turbines, centrifugal pumping units and miscellaneous engines and machinery to Citron-Byer Co., Muirheid Ave., Trenton.

O., Greenwich—City awarded contract for the construction of a pump house including two centrifugal pumps, etc., to T. C. Brooks & Sons Co., Jackson, Mich. $14,700.

R. I., Providence—State of Rhode Island, County Court House, W. B. Greenough, 30 South Main St., received low bids for the construction of an 8 story court house including steam heating and ventilation systems, etc., at College and Benefit Sts. Estimated cost $2,000,000. Jackson, Robertson & Adams, 1216 Turks Head Bldg., are architects.

Tenn., Memphis—Bd. of Water Commissioners will receive bids about August 12, James Sheahan Water Pumping Station at Normal State Teachers College, incl. wells, Layne & Bowler electric pump, etc. Estimated cost $2,000,000. Fuller & McClintock, 170 Bway., New York, are engineers. T. H. Allen, McCall Bldg., Memphis, is associate engineer. This corrects reports in July 7 issue.

Tenn., Nashville—State of Tennessee will soon receive bids for the construction of a group of buildings including administration building and auditorium, agricultural and industrial building, etc. Estimated cost $1,000,000. W. R. McCornack, 10006 Carnegie Ave., Cleveland, O., is architect.

Texas—West Texas Utilities Co., Abilene, plans extensions and improvements at San Angelo and San Angelo District, including single ph. volt rural extension lines and 3 ph., 2300 v. bank of transformers and primary metering equipment for new ice plant; constructing 12 kv. line and 3 ph., 2300 v. line in South Vernon oil field to serve power and lighting demands; 440 v. 3 ph., line near Iraan, to serve central power equipment at Corvette oil field; electric extensions at Rule, etc. Estimated cost $150,000. Part of work will be done by day labor and part by separate contracts.

Tex., San Antonio—A. W. Parker, Constructing Quartermaster, awarded contract for a heating plant for engineering shop at Randolph Field, 14 mi. north of San Antonio to C. Wallace Plumbing Co., 2224 Summer St., Dallas. $17,980.

Vt., Bennington—Bennington College will receive bids until July 20, for three dormitory and one college building on Elm St. Estimated cost $1,000,000. J. W. Ames and E. S. Dodge, 148 State St., Boston, are architects.

Wash., Newport — "Z" Canyon Project, c/o H. L. Cooper, 101 Park Ave., New York, N. Y., Engr., is having preliminary plans prepared for the construction of a hydro-electric development to include dam and power plant, 650,000 hp. total capacity at Canyon Z on Columbia River about 20 miles from Canadian line, also large chemical plant. Initial cost of dam and power house $4,500,000. Total estimated cost approximately $17,600,000. Maturity indefinite.

B. C., Brilliant — West Kootenay Power & Light Co., Ltd., Rossland, B. C., plans development on Kootenay River here to develop 30,000 hp. Estimated cost $4,000,000.

Sask., Regina — Canadian Pacific Railway, Montreal, Que., awarded contract for power house to Bird, Woodhall & Simpson, Ltd., Regina. Estimated cost $80,000.

Italy—Municipalities of Bologna, Naples, Palermo and Milan, plan the construction of refrigerated warehouse and distribution plants for meats and dairy products, also for fruits and vegetables. Each to exceed $1,000,000.

Equipment Wanted

Boiler, Stoker, Handling Equipment, Etc.—Fargo, N. D.—State Board of Administration, E. G. Wanner, Secy., Bismarck, will receive bids until July 25, for a new 400 hp. standing type boiler, traveling gate stoker, handling equipment, etc. for proposed improvements to heating and power plant at State Agricultural College.

Exhaust Fan—St. Louis, Mo.—Aalco Laundry & Cleaning Co., 3700 Olive St., plans to purchase a 36 or 48 in. motor driven, 220 d.c. exhaust fan.

Power Units—Shreveport, La.—Southwestern Gas & Electric Co., plans the installation of additional power units totaling 18,750 kw. Estimated cost $500,000.

Pumping Units—Philadelphia, Pa.—Dept. of ity Transit, C. E. Myers, Dir., City Hall Annex, will receive bids until July 28 for five electrically operated centrifugal sump pumping units complete for Broad St. subway, West Philadelphia branch. Cont. 314.

Refrigerating Equipment—Washington, D. C.—Bureau of Standards will receive bids until July 16, furnishing and installing carbon dioxide refrigerating equipment in Power Plant Building here.

Storage Battery—Wellington, N. Z.—Ministry of Public Works, will receive bids until Aug. 25 for a storage battery complete, 150 amp. capacity for Mangahao power scheme.

Industrial Projects

N. J., Allwood—American Colortype Co., 207 West 25th St., New York, N. Y., is having revised plans prepared and bids taken about July 15 for alterations to plant here. Estimated cost $40,000. Ballinger Co., 12th and Chestnut Sts., Philadelphia, Pa., is architect and engineer.

N. Y., Brooklyn—Rand Rubber Co., Halsey St. and Sumner Ave., awarded contract for addition and alterations to factory to Sracer & Tueru, c/o owner. Estimated cost $40,000.

N. Y., New York — National Screen Service Inc., 126 West 46th St., plans the construction of a 7 story, 98 x 100 ft. factory at 346 to 354 West 40th St. Estimated cost $250,000. J. M. Berlinger, 232 Madison Ave., Archt.

N. Y., Ridgewood—Stahl-Meyer Co., 172 East 127th St., New York, N. Y., awarded contract for the construction of a meat packing plant to W. E. Anderson, 885 Flatbush Ave., Brooklyn. Estimated cost $60,000.

Pa., Carnegie—Superior Paper Products Co., will soon award contract for the construction of first unit of paper plant, 1 story, 80 x 180 ft. Estimated cost $50,000. Braziell & Anderson, 309 4th Ave., Pittsburgh, are architects.

Pa., Palmerton — New Jersey Zinc Co., 160 Front St., New York, N. Y., is having plans prepared for additions to its plant here. New equipment will be installed. Estimated cost with equipment. $150,000.

Tex., Fort Worth—Sinclair Companies, Fort Worth National Bldg., will not make improvements to old Pierce refinery plant here. $2,000,000. Project in abeyance. Company to re-operate refinery without carrying out proposed remodeling program.

Tex., Harlingen—C. W. Parson, Milan Bldg., San Antonio, plans to construct a 1-story, 90 x 110 ft. dry ice plant here. Estimated cost $60,000. Private plans.

Tex., Galveston—Stability Leather Goods Mfg. Co., 2705 Olive St., St. Louis, Mo., is having preliminary plans prepared for the construction of a leather goods plant here. Estmiated cost $100,000. Private plans.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

THE trend continues downward in prices of power-plant and electrical supplies, with lower quotations offered this month, compared with last, on armored cable, conduit, elbows, couplings, friction tape, rubber tape, wire solder, leather belting, belt lacing, cement, and cold-finished steel. Contrary to the general movement, prices advanced in wiping cloths, paint materials, babbitt metal, and certain of the refractories.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket, net, per ft.		$0.51
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		70%

Air—Best Grade, Net

¾-in., per ft.	3-ply	$0.271	4 ply	$0.337

Steam—Discounts from List

First grade	59%	Second grade	60–5%	Third grade	60–10–10%	

RUBBER BELTING—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting:

Best grade 60–10–10% Second grade 70–10%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	40-5%
Heavy	30-10%

RAWHIDE LACING—Cut lacing, best quality, 45%; 2nd quality, 60%. Lace leather sides, best, 15-17 sq.ft., 45c. per sq.ft.; 2nd, 40c., net. Giant or Indian tanned cut lacing, 30-10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $1.60@$1.75 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl. in cloth.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.10 per 100 lb. in lots of 401 to 999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	7.00@11.00	13.00	13.00
Colored	5.50@9.00	9.00	9.00

WIPING CLOTHS—Prices per pound in lots of about six bales (600 lb.), for colored wipers, as follows:

New York	$0.12
Cleveland	.08
Chicago	.09

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Minneapolis	Chicago
Per pound	$0.098	$0.101	$0.088

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list less 65% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, full kegs, per 100 lb.:

New York	$4.00
Chicago	4.00
Pittsburgh mill	2.75

Broken kegs, about 50c. higher.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	20.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	45.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	32@35

BABBITT METAL—Delivered in ease lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	46.00
Commercial genuine, intermediate grade	34.50
Anti-friction metal, general service	28.50
Solder, bar	19.87½

COLD-FINISHED STEEL—Warehouse prices on shafting and screw stock, per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.40	$3.10
Flat or square	3.90	3.90	3.60

BOILER FITTINGS—Discounts from list at New York warehouse:

Copper ferrules	70%
Flanges	50%
Stay bolts	60%
Patch bolts	20%
Fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list, are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	31%	18%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1¼	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U.S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..$0.05 per cut
2½ and 2¾ in.....06 per cut
3-in.....$0.09 per cut
3¼ to 4 in.....10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$20.00	$29.52	$48.25	$67.00
No. 12 solid....	29.00	38.60	58.60	79.50
No. 10 solid....	39.74	50.04	72.37	94.50
No. 8 stranded..	65.71	80.50	101.66	138.00
No. 6 stranded..	86.74	114.00	137.00	195.00

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net:

Size, Inches	GALVANIZED Conduit	GALVANIZED Couplings	GALVANIZED Elbows	BLACK Conduit	BLACK Couplings	BLACK Elbows
¼	$52.15	$3.15	$7.55	$47.31	$2.86	$6.47
⅜	52.75	3.78	7.60	47.91	3.44	6.52
½	53.93	4.42	7.72	49.09	4.02	6.64
¾	68.61	6.34	10.17	62.05	5.78	8.75
1	98.17	8.28	15.19	88.49	7.54	13.09
1¼	132.83	11.67	20.88	119.72	10.71	18.33
1½	158.82	14.46	27.94	143.14	13.26	24.52
2	213.68	19.35	50.82	192.60	17.77	44.55
2½	337.85	27.65	84.15	304.50	25.37	73.89
3	441.80	41.44	216.97	398.19	38.02	189.61
3½	557.58	55.61	474.82	505.14	51.05	414.40
4	681.33	69.30	549.07	619.19	63.60	479.25
4½	793.78	103.32	827.42	721.41	94.76	721.70
5	925.10	114.02	1150.87	840.74	104.61	1004.11
6	1200.61	164.80	1435.97	1090.67	151.12	1253.57

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$14.00
No. 16 cotton reinforced heavy		17.50
No. 18 cotton reinforced light		11.50
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		12.50
No. 16 cotton Canvasite cord		13.60
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$54.00	*59.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	82.00	*89.50

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List Each	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.50
0–30 ampere, less than standard package, per 100	2.75

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Carton quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.05

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$4.40	$6.40	$7.40	$12.60
12	6.40	7.75	9.20	16.00
10	8.50	10.20	11.70	21.00
8	12.20	14.30	16.75	29.00
6	.....	.....	24.60	.....
4	.....	.....	33.40	.....
2	.....	.....	46.00	.....
1	.....	.....	66.00	.....
0	.....	.....	78.00	.....
00	.....	.....	91.00	.....
000	.....	.....	106.00	.....
0000	.....	.....	131.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	⅛ In. or Pendant Cap Key	⅛ In. or Pendant Cap Keyless	⅛ In. or Pendant Cap Pull	⅜ In. Cap Key	⅜ In. Cap Keyless	⅜ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 26c. per lb.; in 100 lb. lots, 24c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 28c. per lb.; in 100 lb. lots, 25c. per lb.
Wire solder, in less than 100 lb., 24c. per lb.; in 100 lb. lots, 20c. per lb.
Soldering paste, 2 oz. cans..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	50%
Less than standard package	45%